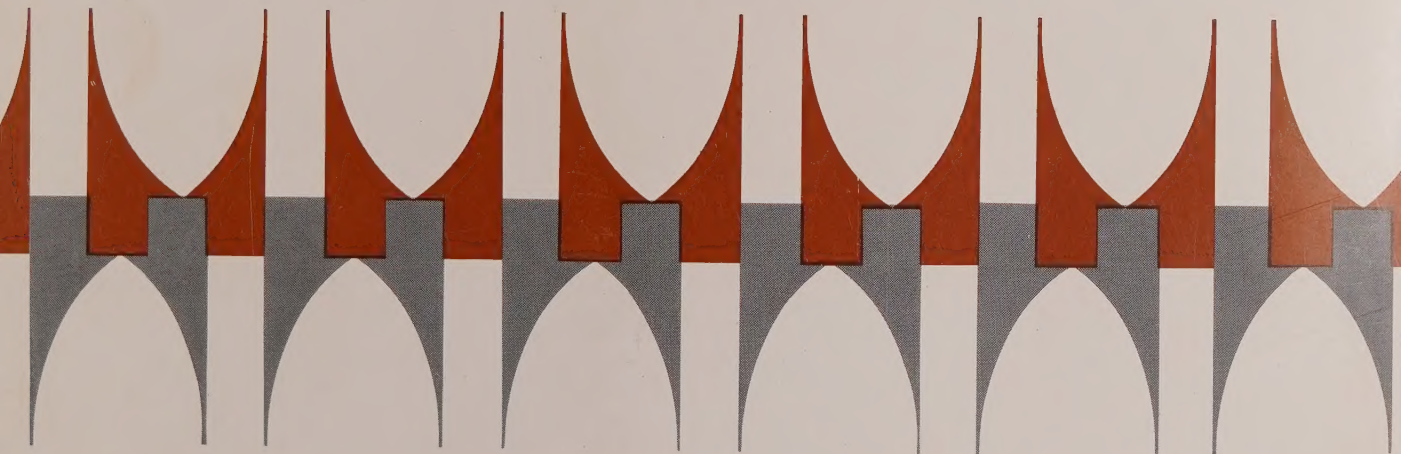


ME 5304

INSTRUCTION MANUAL



MONTRONICS INC.
SUBSIDIARY OF JOHN FLUKE MFG. CO., INC.

SEATTLE, WASHINGTON



MODEL 303A

FREQUENCY SYNTHESIZER

INSTRUMENT SERIAL NO. _____

JUNE 1966

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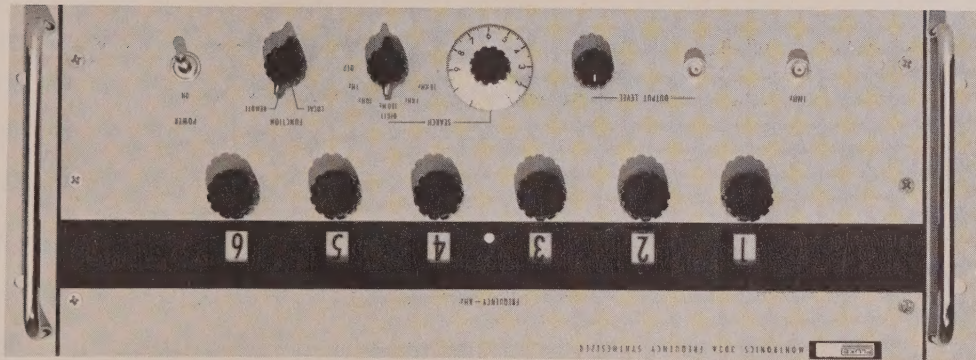
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Model 303A Frequency Synthesizer
showing typical front-panel
controls.





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DRAWINGS

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1.0 GENERAL DESCRIPTION

The Montronics Model 303A Synthesizer has an output frequency range of 50 cps to 1099.999 kc in 1 cps increments. From an external 1 mc standard a coherent spectrum is derived. In a series of arithmetic operations the selected output frequency is constructed directly from these spectral components. The output frequency possesses the long-term stability and accuracy of the frequency standard. The output frequency is selected by decade front panel switches and indicated by an in-line dial readout.

The synthesizer contains a search oscillator which may be used to continuously search any digit up to 10 kc. The search oscillator may be controlled from either the front panel control or from an external voltage. The output level of the synthesizer can be adjusted with the output level control on the front panel. The unit may be remotely programmed utilizing the remote connectors on the rear panel.

1.1 SPECIFICATIONS FOR THE MODEL 303A FREQUENCY SYNTHESIZER

<u>Frequency Range:</u>	50 cps to 1099.999 kc.
<u>Frequency Increments:</u>	1 cps throughout the frequency range.
<u>Standard Frequency Input:</u>	1 mc with the stability required of the output or optional self-contained 1 mc crystal oscillator.
<u>Outputs:</u>	(1) Variable output frequency - maximum - 1 v rms ± 1 db into 50 ohm load, continuously adjustable to less than 0.1 v rms (approximately 30 db) by front panel control. (2) 1 mc from internal frequency standard at 1 v rms nominal into 1000 ohm load, if contained.
<u>Harmonic Content:</u>	Each harmonic of the selected frequency is more than 30 db below the fundamental with output terminated in 50 ohms.

<u>Spurious Content:</u>	All non-harmonically related spurious frequencies are at least 60 db (typically 70 db) below the level of the fundamental at 1 v rms with output terminated in 50 ohm load.
<u>Frequency Selection:</u>	By means of six front panel decade knobs or from remote contact closures in decimal notation. Local-Remote switch on front panel.
<u>Frequency Indication:</u>	In-line dial readout of selected frequency.
<u>Size:</u>	Standard 19" relay rack mounting, 7" high x 17 1/2" deep.
<u>Power Requirements:</u>	115 or 230 vac, $\pm 10\%$, 50-440 cps, approximately 20 watts.
<u>Operating Environments:</u>	Temperature: + 10 to + 40° C. Relative Humidity: 0 to 85%. Shock and Vibrations: As encountered in normal laboratory use.
<u>Search:</u>	A continuously adjustable oscillator can be switched into any decade from 1 cps through 10 kc. This provides continuous tuning of the decades mentioned by either the front panel control or from an external voltage at the rear of the instrument.

2.0 OPERATING INSTRUCTIONS

2.1 INSTALLATION

The unit is carefully packaged to avoid damage during shipment. A close visual inspection should be made upon delivery to determine any physical damage. If damage is found, notify carrier immediately.

The unit is designed for standard rack mounting. It is wired for 102/125 vac, 50-440 cps operation unless otherwise noted.

2.2 CONTROLS AND TERMINALS

2.2.1 Front Panel

The front panel has the following:

1. A power switch to control power to the synthesizer.
2. Six selector knobs which control the appropriate harmonic selector amplifiers to give an output frequency variable in 1 cps, 10 cps, 100 cps, 1 kc, 10 kc and 100 kc steps.
NOTE: that 1 cps through 10 kc selectors are variable 0 through 9, while the 100 kc step selector is variable 0 through 10.
3. Local-Remote switch which provides for local or remote frequency selection.
4. A 1 mc output jack which supplies 1 mc from the internal frequency standard.
5. A synthesizer output jack which supplies the frequency indicated on the front panel readout or remote programmer.
6. An output level control which provides approximately 30 db attenuation of the synthesizer output (below 1 v rms).
7. Search oscillator controls of which the digit control selects the decade to be searched and the calibrated dial which varies the frequency through the range of the decade.

2.2.2 Rear Panel

The rear panel has the following:

1. A synthesizer output jack in parallel with the front panel jack.
2. A 1 mc output jack in parallel with the front panel jack.

3. A 1 mc input jack.
4. An internal or external search control switch.
5. An input jack to accept search oscillator control voltage.
6. A line-cord to supply power.
7. Two fuseholders, 1/2 amp, Slo-Blo to fuse the 115 or 230 vac power to the unit.
8. Remote plugs for remote operation. *

2.3 OPERATIONAL TEST PROCEDURE

The following information and procedure is given to allow the installation personnel and the operators to determine whether or not the synthesizer is operating properly.

2.3.1 Test Equipment Required

1. Frequency Counter - sensitivity of 0.5 volts, frequency range of 10 mc.
2. Oscilloscope - .005 v/cm sensitivity, 10 mc frequency range.
3. Termination - 50 ohm, 1 Watt BNC connector.

2.3.2 Procedure

1. Turn power switch off.
2. Connect power cable at the rear of the unit to a 115 vac outlet.
3. Connect 1 mc standard to 1 mc INPUT on rear panel or connect the 1 mc STD BNC on the rear panel to the 1 mc INPUT BNC with the short jumper provided for units containing a standard.
4. Connect counter (terminated in 50 ohms) to synthesizer output connector on synthesizer.
5. Turn all equipment on.
6. Rotate the selector switches through their full range. The counter readings should be the same as that displayed on the readout. The output should be 1 v rms ± 1 db into 50 ohms between 50 cps and 1.099999 mc.

*Pin connections and logic levels for remote operation are described in Section 2.7.

2.4 ALTERNATIVE OPERATIONAL TEST PROCEDURE

If a counter is not available the synthesis of the output frequency can be checked by using an oscilloscope. **

1. Execute steps 1 through 3, Section 2.3.2. Turn equipment on.
2. Connect an oscilloscope to the synthesizer output, with the synthesizer output terminated in 50 ohms. Place the 1 cps selector to 5. All other digits should be 0's. View the output. (The 5 cps output will be low in amplitude due to roll-off in the output amplifier.) View the output and change the 1 cps selector from '5' to '9'. If the output frequency changes, the units position is synthesized. Leave selector on '9'.
3. Turn the 10 cps selector from '0' to '9'; if output frequency changes the 10 cps decade is synthesized. Leave selector on '9'.
4. Turn the 100 cps selector from '0' to '9'; if output frequency changes the 100 cps decade is synthesized. Leave selector on '9'.
5. Continue this process until all digit positions have been checked.

2.5 SEARCH OSCILLATOR OPERATION

Two steps are required to operate the search oscillator.

1. Select the decade to be searched with the control marked "Digit". By moving counter-clockwise from the off position the search oscillator is inserted in the 1 cps, 10 cps, 100 cps, 1 kc and 10 kc decades. The front panel indicator lights are extinguished in the digit being searched and all lower digits indicating that the lower-order digits cannot be controlled by the front panel switches or remote connectors.
2. For front panel operation by calibrated dial, place the search oscillator switch on the rear panel to INT (internal) operation. For external voltage operation, place the switch on the rear panel to EXT (external) control and connect the control voltage to the BNC on the rear panel labeled 0 to + 12 v. The calibration curve of the search oscillator Figure 1 shows one division of frequency corresponds to 1 v, i. e., for search oscillator searching 10 kc decade the relationship is 10 kc/volt. The search oscillator will accept sweep rates up to 1 kc.

**This procedure will not provide indication of synthesis of increments less than 1 cps.

The search oscillator will operate in either local or remote, for remote operation see Section 2.7.

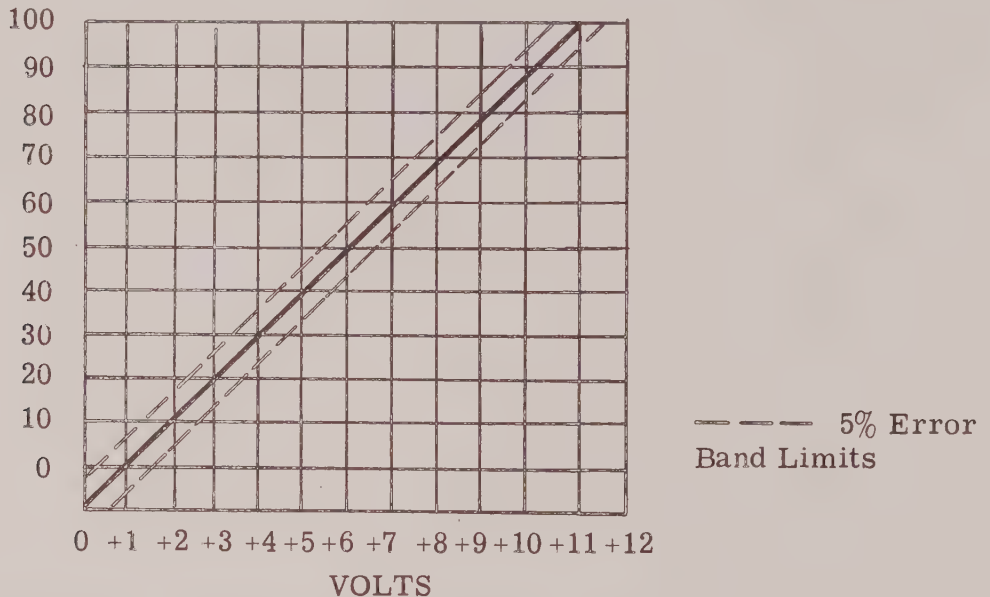


Figure 1. CALIBRATION OF SEARCH OSCILLATOR

2.6 OUTPUT LEVEL

The output level control is a bridged T-pad with 50 ohms input and output impedance, in series with the output.

2.7 REMOTE OPERATION

With the Local-Remote switch in the remote position the control of the front panel selector switches is removed and the synthesizer may be operated by remote contact closures or "Off-On" logic.

The search oscillator controls precede the remote connectors, therefore, the search oscillator may be controlled from the front panel with the synthesizer in remote operation. * The remote connector data is given below. The mating male connector supplied with the instrument is a Cannon DA15P.

*If DC logic is used instead of contact closures the DC level for the digit being searched must be zero volts for all remote pin connections. All lower order remote connectors should have pin 1 at + 12 vdc.

REMOTE CONNECTOR DATA

The connector is wired as given in the table below:

<u>Pin Connector</u>	<u>Digit</u>	<u>Pin Connector</u>	<u>Digit</u>
1	0	7	6
2	1	8	7
3	2	9	8
4	3	10	9
5	4	11	10 (when applicable)
6	5	15	Reference + 12 vdc

The operation is as follows: In the 100's digit, if 2 is connected to 15, the output will be 100 cps. In the 1000's digit, if 3 is connected to 15, the output will be 2,000 cps. In all digits the output will be zero when 1 is connected to 15. The logic for remote programming is - the digit that is "ON" must have + 12 vdc at 2 ma applied to it. All other digits are to be a 0 vdc reference to the instrument ground.

*If DC logic is used instead of contact closures the DC level for the digit being searched must be zero volts for all remote pin connections. All lower order remote connectors should have pin 1 at + 12 vdc.

3.0 THEORY OF OPERATION

The drawing to which each heading under Theory of Operation applies is given after the heading.

3.1 OVERALL FUNCTIONAL DESCRIPTION

Reference: Block Diagram 303A.

The synthesizer derives the desired 50 cps to 1099.999 kc output frequencies from the 1 mc output of the reference frequency standard in such a manner that the derived frequencies have the long-term accuracy and stability of the frequency standard.

The synthesizer is composed of the following circuit modules:

1. 1, 8 and 12 mc Multiplier Buffer Amplifier (MBA) (303A-408).
2. Dual Spectrum Generator Module (DSG) (304A-407A).
3. Digit Unit Module (DU) (304A-401C).
4. 1.00 - 1.09 mc Harmonic Selector Module (1 mc HS) (304A-411).
5. Digit Adder Module (DA) (303-401).
6. 10 mc Harmonic Selector Module (10 mc HS) (303A-403). (Deleted after SN 179).
7. 10.0 - 10.5 mc Harmonic Selector Module (10 mc HS) (303A-409) (SN 180 & On).
8. 10.6 - 11.0 mc Harmonic Selector Module (10 mc HS) (303A-410) (SN 180 & On).
9. Output Mixer Module (OM) (303A-404).
10. Output Amplifier Module (OA) (303A-8-405).
11. Variable Search Oscillator (SO) (304A-420A).

The MBA and DSG process the 1 mc signal from the standard and provide all the frequencies necessary for the operation of the synthesizer.

The outputs from these two modules are distributed to the DU's, the 1 mc HS and the 10 mc HS. DU#1 provides the 1 cps increments of the synthesizer output frequency. DU#2 provides the 10 cps increments of the output frequency. DU#3 provides the 100 cps increments of the output frequency. DU#4 provides the 1 kc increments of the output frequency. The DA provides the 10 kc increments of the output frequency. The 10 mc HS provides the 100 kc increments of the output frequency. The output of the 10 mc HS and the output of the DA are mixed in the OM module resulting in the output. The output is amplified to 1 v rms in the OA.

NOTE: Montronics, Inc., numbers in which the last digits are 100 series refer to schematics. Numbers in which the last digits are 300 corresponds to the printed circuit board and the 400 series indicate a completed module.

3.2 OPERATION

3.2.1 1, 8 and 12 mc Multiplier Buffer Amplifier Module

Reference: Drawing No. 303A-108

The MBA generates 1 mc, 8 mc and 12 mc outputs from the 1 mc input. The 1 mc input signal is applied to a limiter (Q1, Q2) to provide a constant drive level for the crystal filter amplifier (Q3). The 1 mc signal is then applied to limiter (Q4, Q5) and an isolation amplifier (Q13). This amplifier provides the 1 mc signal that is applied to the DSG and first DU. The 1 mc signal from the limiter (Q4, Q5) is also applied to the times four active multiplier (Q6). After multiplication by four, the signal is amplified by (Q7) and applied to a times two active multiplier (Q8) and a times three active multiplier (Q12). The 8 mc signal derived from (Q8) is applied to two isolation amplifiers (Q9, Q10) which provide isolation to the 8 mc signal which is applied to the DU Modules. Amplifier (Q9) drives two DU's while amplifier (Q10) drives the remaining two. The 12 mc signal obtained from (Q12) is applied to an isolation amplifier (Q11) which provides isolation for the 12 mc signal that is applied to the DA Module.

3.2.2 Dual Spectrum Generator Module

Reference: Drawing No. 304A-107A

The Dual Spectrum Generator has a 1 mc input from the MBA. From this input, two spectrums or "combs" are derived. The first contains spectral lines from 1.00 to 1.09 mc at 10 kc intervals. The second contains the spectral lines from 10.00 to 10.9 mc at 100 kc intervals. These spectra are derived from the 1 mc input signal, therefore, the output spectral lines are coherent with the input.

The 1 mc input to the DSG is buffered by the 1 mc amplifier (Q1) and applied to the divide-by-ten synchronized divider (Q2). The resulting 100 kc signal is buffered and cleaned up in the 100 kc buffer (Q3) and applied to the synchronized divider (Q4). The dividers are driven into synchronism by the positive going portion of each 10th input cycle. During this time, the collector voltage is driven sharply negative. This portion of the divider collector waveform is used to drive the pulse shaper (Q5 and Q6). In the quiescent state, Q5 is saturated, Q6, Q7 and Q8 are cut-off and Q9 is biased for linear operation.

The sharply negative portion of the collector voltage of Q4 is differentiated by capacitor C17 to drive Q5 into cut-off for a period determined by C17 and R12. The resulting pulse is amplified by amplifier Q6 and applied to the emitters of Q7 and Q8 to forward bias those transistors, or to "turn on" the gate. The 1 mc signal to be gated is fed from the output of Q1 to the base of Q8. The result is a train of bursts of 1 mc signal at a 10 kc repetition rate. The bandwidths of tuned circuits T4 and T5 are designed to confine the output energy content to the desired 1.00 to 1.09 mc. The output amplifier (Q9) buffers and amplifies the spectrum. The drive pulse for the 10.0 to 11.0 mc spectrum is obtained in a manner as previously described. The portion of the input signal that drives the collector voltage of Q2 sharply negative is differentiated by (C25 and R26) to generate the "turn-on" by the pulse shaper (Q10 and Q11). The resulting pulse, forward biases and gates the keyed oscillator "ON" at a 100 kc repetition rate. The output from the keyed oscillator (Q12) is a train of bursts about 10 mc. The spectrum in the 10 to 11 mc region are then amplified by the output amplifier (Q13).

3.2.3 Digit Unit Modules

Reference: Drawing No. 304A-101C

The Digit Unit selects a nominal 1 mc signal from the 1.00 - 1.09 mc spectrum or the Search Oscillator. This 1 mc is added to 8 mc (from the MBA), the sum of which is amplified through a 9 mc IF. This nominal 9 mc signal is then mixed with 1 mc (from either the MBA or from the previous DU) to obtain a nominal 10 mc signal. The 10 mc signal is divided by 10 to obtain an output of 1 mc.

The 1.00 - 1.09 mc spectrum is amplified by amplifier (Q11) and then fed to the piston trimmers C1 through C10. Nine of the ten crystal filters are normally off, the active filter selects one of the frequencies present in the spectrum. When the Search Oscillator is used the gate Q22 is ON and all the filter steps are OFF. The setting of the associated DC control circuitry determines which filter stage is active. The common transformer T1 feeds the selected frequency to amplifier Q12.

The nominal 1 mc signal is amplified in amplifier (Q12) and fed to the 9 mc balanced mixer Q13 and Q14. This mixer combines a fixed 8 mc and the nominal 1 mc signal from the digit filters to give a nominal 9 mc signal. This is fed through the double-tuned stage T3 and T4 to the 10 mc mixer Q16 and Q17. A 1.00 mc signal from the MBA or a nominal 1 mc from the previous Digit Unit is amplified by amplifier (Q15). This signal is fed to the balanced 10 mc mixer, Q16 and Q17. The resulting 10 mc (nominal) signal is amplified by amplifier Q18 to drive the 10-to-1 synchronized divider (Q19 and Q20). The output of the divider is amplified by amplifier (Q21) and is available at pin 5 on the Methode plug.

3.2.4 1.00 - 1.09 mc HS Module

Reference: Drawing No. 304A-111

This module receives the 1.00 - 1.09 spectrum from the DSG module and selects the appropriate frequency (1.00 mc, 1.01 mc, . . . 1.09 mc) from the spectrum to give the 10 kc steps of the synthesizer. Ten crystal filters and amplifiers enable the selection of any one of the ten frequencies present in the spectrum. The setting of the 10 kc knob or control circuitry determines which filter-amplifier stage is active. The output is 1.0e and is fed to the Digit Adder Module. When the 10 kc digit is being searched, a broadband gate is turned on in place of the crystal filters. This gate allows the search oscillator signal to replace the fixed frequencies from the crystal filters.

The spectrum is amplified by Q1 and fed to the trimmers along the top of the module. The piston trimmers are used to tune the crystals to their respective frequencies and the ceramic trimmers are used to balance the crystal bridge circuit. This balancing reduces the 10 kc spurious signals in the output to at least -60 db. The collectors of the output transistors (Q4) of the filter stages are common with one output transformer (T2). The search gate transistor collector (Q5) is also tied to this common line.

3.2.5 Digit Add Module

Reference: Drawing No. 303-101

The Digit Add Module receives a 1.00dcba mc signal from DU#4, a 1.0e mc signal from the 1 mc HS and a 12 mc signal from the

MBA module. The 12 mc signal is used to translate and invert the 1.0e mc signal from the 1 mc HS into an 11 mc IF to yield 12 - 1.0e mc. This output is then mixed with the 1.00dcba mc input from the DU#4 to yield the 10 mc input signal (10 - .0edcba) to the mixer in the OM module.

The 1.0e mc signal from the 1 mc HS is fed to selective amplifiers (Q1, Q2) which in turn drive the 11 mc balanced mixer (Q3, Q4). The 11 mc balanced mixer combines the 1.0e mc signal from the 1 mc HS and the 12 mc signal from the MBA. The nominal 11 mc signal is amplified (Q5, Q6) and fed to the balanced mixer (Q8, Q9). The 1.00dcba mc signal from DU#4 is amplified by the balanced mixer 10 mc signal (10 - 0edcba) which is fed through amplifiers (Q10, Q11, Q12) to provide one of the inputs to the Output Mixer Module.

3.2.6 10.0 - 11.0 mc Harmonic Selector Module (Deleted after SN 179)

Reference: Drawing No. 303A-103

This module receives the 10.0 - 11.0 mc spectrum and selects the appropriate frequency (10.0 mc, 10.1 mc . . . 11.0 mc) from the spectrum to give the 100 kc steps of the synthesizer. Eleven crystal filters and amplifiers enable the selection of any of the eleven frequencies present in the spectrum. The position of the 100 kc digit selector knob or control circuitry determines which filter-amplifier stage is active. The output of this module is 10.f and is fed into the Output Mixer. The setting of the 100 kc knob or control circuitry indicates which filter is active. If "0" is selected, the "Digit 0 Filter" is active; if "1" is selected, "Digit 1 Filter" is active, etc.

The 10.0 - 11.0 mc spectrum is fed to the trimmer capacitors (C3) along the top of the board. Two piston trimmers (C3, C4) are used per filter to tune the crystals (Y1, Y2) to their respective frequencies. The collectors of the output transistors (Q2) of the filter stages are common with one output transformer (T2).

3.2.7 10.0 - 10.5 mc Harmonic Selector Reference: Dwg. No. 303A-109 10.6 - 11.0 mc Harmonic Selector Reference: Dwg. No. 303A-110 (SN 180 & On)

These two modules receive the 10.0 - 11.0 mc spectrum and select the appropriate frequency (10.0 mc, 10.1 mc . . . 11.0 mc)

from the spectrum to give the 100 kc steps of the synthesizer. Six crystal filters and amplifiers in the 10.0 to 10.5 mc Harmonic Selector enable the selection of any of the first six frequencies (10.0 to 10.5 mc) present in the spectrum. Five crystal filters and amplifiers in the 10.6 to 11.0 mc Harmonic Selector enable the selection of the last five frequencies (10.6 to 11.0 mc) present in the spectrum. The position of the 100 kc digit selector knob or control circuitry determines which filter-amplifier stage is active. The output frequency of these two Harmonic Selectors is fed into the Output Mixer.

The 10.0 - 11.0 mc spectrum is fed to the trimmer capacitors (C3) along the top of the two Harmonic Selector Modules. Two piston trimmer capacitors are used, per filter, to tune the crystals (Y1, Y2) to their respective frequencies. The collectors of the output transistors (Q2) are common with one output transformer (T2).

3.2.8 Output Mixer Module

Reference: Drawing No. 303-104

The output mixer receives 10. f mc from the 10 mc HS and 10.0 - 0.0edcba mc from the DA. These signals are mixed, fed through a low-pass filter, then to the Output Amplifier.

The input from the 10 mc HS is fed into a limiter (Q1) and then to the AGC'd amplifier Q2 which is regulated by the current source Q10. The AGC'd signal is amplified in amplifier (Q3) and presented as the linear signal to the balanced mixer Q6 and Q7. The signal from Q3 is also presented to the AGC detectors Q4 and Q5. The switching signal to the balanced mixer is obtained by amplification of the 10-.0edcba mc signal in amplifier Q8. The difference frequency 0. fedcba mc is fed through the low-pass filter to emitter follower Q9. This signal is fed to the OA Module.

3.2.9 Output Amplifier Module

Reference: Drawing No. 303-105

The difference frequency from the OM Module is fed to amplifier (Q1) in the OA Module. The OA Module further consists of an

amplifier (Q2) and the complementary emitter-follower (Q3, Q4). The amplifier delivers a 1 volt (nominal) signal into 50 ohms. The signal level is maintained by AC feedback in the output amplifier (from output to Q1 emitter) and the AGC circuit in the output mixer module.

3. 2. 10 Search Oscillator Module

Reference: Drawing No. 304A-120

Replacing a digit with the search oscillator allows the synthesizer to be continuously varied over the decade it replaces. As a convenience the oscillator will overrange by 10% on either end.

If the search switch (front panel) is "off" the oscillator is not running because + 12 is not applied to pin 19. As the search switch is turned counter-clockwise the oscillator turns "on" and the lights in back of the readout dials go out in sequence, signifying the highest order decade being searched. When the search oscillator is inserted in a decade the digit filters on the DU Modules, that select discrete signals, are "off" and the search gate is "on".

The oscillator is controlled by the DC voltage input from the front panel or from an external source, compared in a discriminator and corrected by a comparator to compensate for varicap curvature and temperature drift.

The oscillator (Q1) is a modified Colpitts, which is frequency controlled by voltage variable capacitor (CR1) and is amplitude stabilized by AGC circuit (CR2, CR3, Q2, Q3 and Q4). The constant amplitude output is fed through the discriminator (Q5, Q6, Q7 and Q8) to the detector (CR4, CR5, CR6 and CR7).

The DC voltage from the discriminator-detector is compared to a portion of the input DC voltage (R37) in comparator (Q9, Q10 and Q11); a correction voltage is fed back to the oscillator voltage variable capacitor (CR1). The closed-loop frequency control serves to keep the oscillator frequency within the allowed deviation. The oscillator signal is fed through amplifier (Q12, Q13) for distribution to the synthesizer to the DU and 1 mc HS gates.

care should be administered in beginning any adjustment. Begin any adjustment by first turning the slug into the transformer.

4.2 TROUBLESHOOTING

4.2.1 General

The key to troubleshooting any piece of electronic equipment is (1) fully understanding the operation of the total unit and each of its parts and (2) localizing the defective stage through a logical, methodical, troubleshooting procedure. Section 3.0 (Theory of Operation) should be understood thoroughly before attempting to troubleshoot any part of the synthesizer.

With the knowledge gained from the Theory of Operation and the schematic diagrams no difficulty will be encountered in servicing the synthesizer.

4.3 WARRANTY

Montronics, Inc., warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under the Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify Montronics, Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.
2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested,

an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

Shipping - All shipments of Montronics, Inc., instruments should be made via airfreight prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

Claim For Damage in Shipment - The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to Montronics, Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

Montronics, Inc., will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

Montronics, Inc.
Subsidiary of John Fluke Mfg. Co., Inc.
P. O. Box 7428
Seattle 33, Washington 98133

5.0 ALIGNMENT

5.1 GENERAL

Section 3.0 should be studied and the operation of all circuits understood before alignment or calibration is attempted. Where control settings are not specified, their setting is not important. The unit must be "ON" for all alignment procedures.

Access may be gained to the tuning adjustments by removing the printed circuit card and attaching it to the extender board supplied. The printed circuit cards should not be removed from their sockets with the power on. All other cards should be in place when one card is aligned.

In order to measure the frequencies present at certain test points in the synthesizer, the counter is connected at all times to the vertical amplifier (or any other isolation amplifier) preventing circuit loading that might be caused by a low-impedance counter input. The various counted frequencies, where they are important, are given in the alignment procedure.

An external 1 mc frequency standard must be connected to the 1 mc jack and used as the driving source for the synthesizer. (Or the internal oscillator may be used if the synthesizer is so equipped. In this case an external source may be used if the internal oscillator is removed). It should have an output of 1 v rms into 50 ohms and a stability better than the long-term stability required of the synthesizer output frequency. The Q of the selector and filter circuits is such that a signal generator is too unstable to be used for the 1 mc input.

The spectrum analyzer is used to display the spectrum existing at various test points in the synthesizer. The spectrum analyzer controls should at all times be set to accurately display any spurious signals up to 50 db down from the desired signal. A medium sweep rate and logarithmic calibration is used for all displays.

The digital readout on the front of the synthesizer shows the selected synthesizer output frequency in cycles per second. At various points in the alignment procedures, the instruction might say "Set the 1 kc selector switch to 1". This means that the 1 kc selector switch is to be rotated until 1 appears in the readout. If the numbers appearing at the other positions are not specified, they are not important.

The words "maximum" or "minimum" refer to the amplitude of the signal being observed on the oscilloscope or VTVM. A statement such as tune C4 for maximum, means tune or adjust C4 until the height of the oscilloscope display or VTVM reading reaches its maximum value.

5.2 EQUIPMENT REQUIRED

Frequency Counter - With sensitivity of 0.1 v rms and frequency coverage of 12 mc.

Spectrum Analyzer - With resolution of 1 kc to cover frequency range of 10 cps to 12 mc.

VTVM

Oscilloscope - Sensitivity of 0.005 v/cm frequency range of 20 mc.

RF Millivoltmeter - Frequency range up to 20 mc.

Frequency Standard - 1 mc, 1 v into 50 ohms, stability of 1×10^{-8} .

NOTE: Use care and observe frequency limitations and loading affects of instruments.

5.3 ALIGNMENT OF MODULES

5.3.1 1, 8 and 12 mc Multiplier Amplifier Module, 303A-408A

Reference: Drawing No. 303A-108

1. Connect oscilloscope to TP1 with ground connection to TP12. Check for 1 mc signal. (Nominal 2 volt p-p)*
2. Connect oscilloscope to TP2. Adjust T1, C7 and T2 for maximum 1 mc signal. (Nominal 1.5 volt p-p).
3. Connect oscilloscope to TP3 and adjust T3 for maximum 1 mc signal.
4. Connect oscilloscope to TP4 and adjust T11 for maximum 1 mc signal. (Nominal 200 millivolts p-p).
5. Connect oscilloscope to TP5 and adjust T4 for maximum 4 mc signal. (Nominal 1 volt p-p).
6. Connect oscilloscope to TP6 and adjust T5 for maximum 4 mc signal. (Nominal 2.8 volt p-p).
7. Connect oscilloscope to TP7 and adjust L1 and T6 for maximum 8 mc signal. (Nominal 300 millivolt p-p).
8. Connect oscilloscope to TP8 and adjust T7 for maximum 8 mc signal. (Nominal 300 millivolts p-p).
9. Connect oscilloscope to TP9 and adjust T8 for maximum 8 mc signal. (Nominal 50 millivolts p-p).

*p-p is peak-to-peak voltage

10. Connect oscilloscope to TP10, adjust L2 and T10 for maximum 12 mc signal. (Nominal 300 millivolts p-p).
11. Connect oscilloscope to TP11 and adjust T9 for maximum 12 mc signal. (Nominal 1 volt p-p).

5.3.2 Dual Spectrum Generator Module 304A-407B

Reference: Drawing No. 304A-107A

1. Connect oscilloscope between TP1 and TP7 (ground). Adjust transformer T1 for maximum 1 mc signal. 500 mv p-p.
2. Connect oscilloscope to TP2. Remove MBA module and adjust T2 for frequency of 100 kc $\pm$ 100 cps.
3. Replace MBA Module. Check counter for 100.00 kc. Adjust T3 for maximum 100 kc signal, 600 mv - 900 mv p-p.
4. Connect oscilloscope to TP3 and ground the collector of Q2. Adjust L1 for the 10 kc $\pm$ 100 cps. Remove ground from collector of Q2. Check counter for 10.000 kc signal, 550 mv - 800 mv p-p.
5. Connect spectrum analyzer to TP4 and calibrate it to display 1.00 to 1.09 mc. Adjust T4 for maximum amplitude of the 1.05 mc spectral line. Adjust T5 for maximum amplitude of the 1.09 mc spectral line. Re-adjust T4 and T5 as necessary, until the spectrum is within 1 db between 1.00 mc and 1.10 mc, 250 mv - 350 mv p-p.
6. Connect analyzer to TP6 and adjust to display 10.0 to 11.0 mc. Tune L2 for maximum 10.0 spectral line. Tune T6 for maximum 11.0 mc spectral line. Re-adjust L2 and T7 as necessary until the spectrum is within 1 db between 10.0 mc and 11.0 mc, 1.00 - 2.00 v p-p.

5.3.3 Digit Unit Modules 304A-401C

Reference: Drawing No. 304A-101

1. Set all transformer slugs approximately flush.
2. Connect oscilloscope to TP1 for steps 3 and 4.
3. Select Digit "0" on DU being aligned.
4. Adjust trimmers C2 through C10 for maximum as selector switch is rotated 0 through 9. See Table 1.

TABLE 1

<u>Switch Setting</u>	<u>Adjustment</u>	<u>Amplitude</u>
0	C1 and T1	.70 - 1.00 v p-p
1	C2	.50 - 1.00 v p-p
2	C3	.50 - .80 v p-p
3	C4	.30 - .60 v p-p
4	C5	.30 - .60 v p-p
5	C6	.20 - .50 v p-p
6	C7	.20 - .50 v p-p
7	C8	.18 - .30 v p-p
8	C9	.15 - .30 v p-p
9	C10	.10 - .25 v p-p

5. Connect oscilloscope to TP2. Select Digit "9" on DU. Tune T2 for maximum (at TP2 the 8 mc should be approximately 200 mv, the 1 mc should be approximately 30 mv).
6. Connect oscilloscope to TP3. Select Digit "5" on DU being aligned. Tune T3 and T4 for maximum 9 mc.
7. Set all previous DU's for Digit "5". Tune T5 for maximum 1 mc. (The 9 mc should be 150-450 mv p-p and the 1 mc should be 75-100 mv p-p.)
8. Connect oscilloscope to TP4. Tune T6, L1 and T7 for maximum. (Level at TP4 should be 0.5-0.9 v p-p.)
9. Connect oscilloscope to TP5. Let oscillator free-run by pulling previous DU or MBA Module. Set free-running frequency with T8 to approximately 10.07 mc.
10. Adjust T9 for maximum. Repeat steps 9 and 10 as necessary.
11. Replace DU or MBA and tune T9 for maximum. (Output should be 200-300 mv p-p.)
12. Observe output with counter, as selector of DU under alignment is rotated from 0 through 9. Check for proper synthesis of each digit.

5.3.4 1 mc Harmonic Selector Module 304A-411A

Reference: Drawing No. 304A-111

1. Connect oscilloscope between TP1 and TP2 (ground). Set the 10 kc selector switch to 5. Adjust C6 and T1 (on digit 5) and T2 for maximum 1.05 mc signal.

2. With the oscilloscope connected to TP1 make the adjustments for maximum signal indicated in Table 2.

TABLE 2

10 kc Selector Switch Setting	Adjust for Maximum Signal	Adjust for Minimum Spurious Signal	Level
0	C6 and T1 digit 0	C7 digit 0	280-500 mv p-p
1	C6 and T1 digit 1	C7 digit 1	0.28 - 1.2 v p-p
2	C6 and T1 digit 2	C7 digit 2	0.28 - 1.2 v p-p
3	C6 and T1 digit 3	C7 digit 3	"
4	C6 and T1 digit 4	C7 digit 4	"
5	C6 and T1 digit 5	C7 digit 5	"
6	C6 and T1 digit 6	C7 digit 6	"
7	C6 and T1 digit 7	C7 digit 7	"
8	C6 and T1 digit 8	C7 digit 8	"
9	C6 and T1 digit 9	C7 digit 9	280-500 mv p-p

3. Connect spectrum analyzer to TP1. Set the analyzer to view -60 db. Make adjustments for spurious as indicated in Table 2.
4. Connect oscilloscope to TP1 and adjust T2 for equal amplitudes when the 10 kc selector switch is set at 0 and 9.

5.3.5 10.0 to 11.0 mc Harmonic Selector 303A-403 (Deleted after SN 179)

Reference: Drawing No. 303A-103

1. Connect oscilloscope between TP1 and TP2 (ground). Set the 100 kc selector switch to 5. Adjust C3, C4 and T1 for digit filter 5 and T2 for maximum 10.5 mc signal.
2. With oscilloscope connected to TP1 make the adjustments for maximum signal indicated in Table 3.

TABLE 3

Selector Switch	Adjustments	Filter Digit	Frequency	Level
0	C3, C4, T1	0	10.0 mc	0.4-0.8 v p-p
1	"	1	10.1 mc	0.4-0.8 v p-p
2	"	2	10.2 mc	0.4-0.8 v p-p
3	"	3	10.3 mc	0.4-0.8 v p-p
4	"	4	10.4 mc	0.4-0.8 v p-p
5	"	5	10.5 mc	0.4-0.8 v p-p
6	"	6	10.6 mc	0.4-0.8 v p-p
7	"	7	10.7 mc	0.4-0.8 v p-p
8	"	8	10.8 mc	0.4-0.8 v p-p
9	"	9	10.9 mc	0.4-0.8 v p-p
10	"	10	11.0 mc	0.4-0.8 v p-p

3. Change the selector switch from 0 to 10. The amplitudes at position 0 and 10 should be within 10% of each other. If they are not, readjust T2 until they are.

5.3.6 10.0 to 10.5 mc Harmonic Selector (303A-409) (SN 180 & On)

Reference: Drawing No. 303A-109

1. Connect oscilloscope between TP1 and TP2 (ground). Set the 100 kc selector switch to 3. Adjust C3, C4 and T1 for digit filter 3 and T2 for maximum 10.3 mc signal.
2. With oscilloscope connected to TP1 make the adjustments for maximum signal indicated in Table 4.

TABLE 4

Selector Switch	Adjustments	Filter Digit	Frequency	Level
0	C3, C4, T1	0	10.1 mc	0.4-0.8 v p-p
1	"	1	10.1 mc	0.4-0.8 v p-p
2	"	2	10.2 mc	0.4-0.8 v p-p
3	"	3	10.3 mc	0.4-0.8 v p-p
4	"	4	10.4 mc	0.4-0.8 v p-p
5	"	5	10.5 mc	0.4-0.8 v p-p

3. Change the selector switch from 0 to 5. The amplitudes at position 0 and 5 should be within 10% of each other. If they are not, readjust T2 until they are.

5.3.7 10.6 to 11.0 mc Harmonic Selector (303A-410)

Reference: Drawing No. 303A-110 (SN 180 & On)

1. Connect oscilloscope between TP1 and TP2 (ground). Set the 100 kc selector switch to 8. Adjust C3, C4 and T1 for digit filter 8 and T2 for maximum 10.8 mc signal.
2. With oscilloscope connected to TP1 make the adjustments for maximum signal indicated in Table 5.

TABLE 5

Selector Switch	Adjustments	Filter Digit	Frequency	Level
6	C3, C4, T1	6	10.6 mc	0.4-0.8 v p-p
7	"	7	10.7 mc	0.4-0.8 v p-p
8	"	8	10.8 mc	0.4-0.8 v p-p
9	"	9	10.9 mc	0.4-0.8 v p-p
10	"	10	11.0 mc	0.4-0.8 v p-p

3. Change the selector switch from 6 to 10. The amplitudes at position 6 and 10 should be within 10% of each other. If they are not, readjust T2 until they are.

5.3.8 Digit Add Module, 303-401

Reference: Drawing No. 303-101

1. Connect the oscilloscope to TP1 and set the 10 kc selector switch to 5. All other selector switches should be at 0. Tune T1 for maximum, counter should read 1.05 mc (150 mv p-p).
2. Connect oscilloscope to TP2 for tuning double-tuned circuit, L1 and T2. Connect TP3 to TP12. Tune L1 for maximum, 1.05 mc on oscilloscope (1.3 v p-p).
3. Disconnect TP3 from TP12. Tune T2 for minimum. Observe TP3 for equal amplitude of nominal 1 mc signal as the respective selector switch is rotated through every position. Repeat steps 1 through 3 as necessary to achieve equal amplitude. (180 mv p-p).
4. Connect oscilloscope to TP5, connect TP6 to TP12. Return selector switch to position 5. Tune T3 and L2 for maximum 10.95 mc signal. (1.4 v p-p).

5. Remove jumper from TP6 and TP12. Tune T4 for minimum. (600 mv p-p).
6. Adjust R12 for minimum 1.05 mc modulation on the 10.95 mc signal.
7. Connect oscilloscope to TP7. Tune T5 for maximum amplitude of the 10.95 mc component of the 10.95 and 1.00 mc signals seen on the oscilloscope on TP7. (200 mv p-p).
8. Observe the nominal 11 mc signal to see that the amplitude is equal in all positions of the selector switch. If not, repeat steps 4 through 8.
9. Set the 1 kc selector switch to 5. Observe the 1.005 mc signal component of the 10.95 and 1.005 mc signals at TP7. Tune T6 for maximum 1.005 mc signal. (500 mv p-p).
10. Set the 10 kc selector switch to position 5 and the 1 kc selector switch to 0. Connect oscilloscope to TP8, connect TP9 to TP12 with jumper. Tune T7 and L3 for maximum 9.95 mc signal. (3.0 v p-p).
11. Disconnect jumper from TP9 and TP12. Tune T8 for minimum. (1.0 v p-p).
12. Adjust R29 for minimum 1 mc modulation on 9.95 mc signal.
13. Connect oscilloscope to TP10 and tune T9 for maximum. (1.0 v p-p).
14. Connect oscilloscope to TP11 and tune T10 for maximum. (500 mv p-p).

5.3.9 Output Amplifier 303A-8-405

Reference: Drawing No. 303-105

1. Connect a VTVM and a 50 ohm load to the output of the synthesizer. Adjust R1 fully clockwise.
2. Proceed with the following section, then adjust R1 for 1 v rms output.

5.3.10 Output Mixer 303A-404

Reference: Drawing No. 303A-104

1. Connect the oscilloscope to TP2. Set the 100 kc selector switch to 0.
2. Turn R6 1/8 turn from fully counter-clockwise and R18 fully counter-clockwise. Tune T1 for maximum signal.

3. Connect oscilloscope to TP3. Set the 100 kc selector switch to 10. Tune T2 for maximum signal.
4. Connect the oscilloscope to TP6. Set the 100 kc selector switch to 5. Tune T3 for maximum signal.
5. Set the 100 kc selector switch to 0. Set the 10 kc selector switch to 5. (Leave this selector on 5 for remainder of alignment.)
6. Tune T4 for maximum signal on VTVM at synthesizer output.
7. Rotate 100 kc selector through its range and set for minimum signal. Adjust R6 for 1.3 v rms at the output.
8. Adjust R18 to reduce the signal at synthesizer output by approximately 1 db.
9. Adjust output amplifier as indicated in preceding section to achieve an output level of 1.0 v rms ± 1 db with a 50 ohm termination.

5.3.11 Search Oscillator, 304A-420

Reference: Drawing No. 304A-120

1. Turn search switch on. Connect VTVM to TP3 (30 v scale). Check search dial. Dial scale should be aligned such that 0 volts (TP3) corresponds to -1 v on the dial plate.
2. Set search dial to 10. Adjust R1 for exactly 11 volts at TP3. Turn search switch off. Disconnect VTVM. Set search dial to -1.
3. Connect signal generator to TP4 and TP1 (ground) to align discriminator.
4. Connect VTVM between TP5 and ground. Set VTVM for center reading on 3 v scale.
5. Set signal generator to 950 kc and adjust L2 for maximum (+) reading of VTVM. (Control generator output approximately 10 mv, to keep VTVM on scale.)
6. Set signal generator to 1190 kc and adjust L3 for maximum (-) reading on VTVM. (Control generator output to keep VTVM on scale.)
7. Repeat steps 5 and 6. Disconnect generator.
8. Turn search switch on and observe oscillator waveform at TP2 approximately 1 v p-p on oscilloscope.
9. Connect counter to TP2 and adjust L1 to read 1040 kc, ± 5 kc on counter.

10. Align output amp as follows: Connect jumper from TP9 to TP1 and connect oscilloscope to TP8.
11. Adjust L4 for maximum indication on oscilloscope. Remove jumper (step 10) and adjust T1 for minimum indication on oscilloscope, (1.8 v - 3 v p-p). Remove oscilloscope and counter to TP10 for oscillator adjustment. TP10 level 280 mv - 350 mv p-p.
12. Connect jumper from TP6 to TP7. Set search knob to 0 (1 volt at TP3) and adjust L1 for 1000 kc on counter ± 1 kc.
13. Set search knob to 10 and adjust R5 for 1100 kc on counter ± 1 kc.
14. Repeat steps 12 and 13 until both readings are within 5 kc of nominal values and remove jumper (step 12).
15. Set search knob to 0 and adjust R34 for 1000 kc on counter.
16. Set search knob and adjust R37 for 1100 kc on counter.
17. Repeat steps 15 and 16 until readings are within .3 kc of nominal values.

5.3.12 Power Supply

The power supply has two adjustments, one for the + 12 and one for the -12 volt supplies. The adjustments have been set at + 12.5 volts and -12.5 volts, respectively, when the power supply was installed in the unit.

This power supply is designed to take short-circuit conditions for a short period of time without permanent damage to the unit. If short-circuit condition continues for an extended period of time, permanent damage may result, therefore, a 1/2 amp Slo-Blo fuse is recommended.

The base diagram of the power supply is shown on the chassis wiring diagram. For 230 operation remove jumpers between (1 and 2) (3 and 4), then install a jumper between 2 and 3.

5.3.13 Frequency Standard (if applicable)

The 1 mc Frequency Standard requires no alignment in normal operation. However, it has a mechanical tuning adjustment.

A mechanical adjustment can be made by removal of a gasketed screw at the top of the hermetically sealed unit.

CAUTION: Use insulated tool only, such as the JFD alignment tool provided with the synthesizer.

The base diagram of the frequency standard is given in the chassis wiring diagram.

6.0 REPLACEABLE PARTS

The parts used in this unit have been carefully selected to assure maximum reliability. Should component replacements become necessary, identical components should be used. All parts are available from the manufacturers indicated on the parts list or from MONTRONICS, INC. Any abbreviations or contractions used here or on the schematics are standard in the industry.

6.1 LIST OF MANUFACTURERS

AM	Amphenol-Borg
CAN	Cannon
CRL	Centralab
DC	Dialco
EL	Elco Manufacturing
GE	General Electric
GRY	Grigsby
K-K	Kurz-Kasch
M	Montronics, Inc.
OAK	Oak Manufacturing Co.

6.2 PARTS LIST

Parts peculiar to the synthesizer are listed on pages 26 and 27.

Capacitors:

All disc, dipped mica, poly and electrolytic capacitor values are shown on the schematics. Any high quality disc, with 50 vdc rating or higher, dipped mica with a $\pm 5\%$ tolerance, 50 vdc rating or higher may be used as a replacement. The voltage rating of all electrolytics is designated on the schematic. Poly capacitors are marked with "PE series", value, and tolerance.

Resistors:

All resistor values are shown on the schematic. Any high quality, fixed, carbon-composition resistor with a $\pm 5\%$ tolerance may be used as a replacement.

Variable resistors are marked as to type and value; any compatible replacement may be used.

Transistors:

Types of transistors and diodes were kept to a minimum in the synthesizer. The types are shown on the schematics; therefore, they are not listed in the parts list. Any quality replacement of the same type number may be used in case of failure or replacements may be purchased from the factory.

Fixed Inductors:

All decoupling and fixed filter inductors are standard tolerance "Weeductor" by Nytronics; however, any quality inductor of compatible value, tolerance and physical dimensions may be used as replacements. The exceptions to the above are the inductors used in the bias and filter for the frequency standard in units so equipped. These are #6302 J. W. Miller Co.

Variable Inductors and Transformers:

All variable inductors and transformers have a Montronics part number affixed and are so designated on schematics.

Crystals, Trimmer Capacitors and Sockets:

Crystals are imprinted with a 7-digit reference number and operating frequency. Replacements may be obtained from the factory.

Two types of trimmer capacitors are used in the Montronics instruments.

1. Glass piston - Roanwell, Type SG11148
2. Variable ceramic imprinted with value and temperature coefficient - available from Erie Resistor or Montronics, Inc.

Test Points:

Test points of various colors and styles are designated by the following Montronics part numbers:

Horizontal yellow	149138
Horizontal green	149120
Horizontal black	149112

Printed Circuit Connectors:

PCB connectors are manufactured by Methode and carry the following Montronics part numbers:

22 pin male	149351
22 pin female	149393
24 pin male	175240
24 pin female	174847

Modules:

All modules may be ordered from Montronics according to the module number in Section 3. 1.

303A

PARTS LIST

Description	Part No.	Source
Power Supply	302-426A	M
PC Guides	9016-1205	EL
Power Switch	114850	M
Pilot Light Assembly	102-8430-931	DC
Handles	101717	M
Ferrules	100420	M
Front Panel	303A	M
BNC's Female	UG-1094A/U	AM
Line Cord	102822	M
Fuseholders	100107	M
Fuses	F103	M
Sockets (22 pin for modules)	149393	M
Sockets (24 pin for modules)		M
Remote Connector Female on Chassis	DA-155338	CAN
Remote Connector Male	DA-15P	CAN
Hood for Male Remote Connector	DA-20861	CAN
Locking Device for Male Remote Connector	DA-051220-1	CAN
Post for Male Remote Connector	D53078	CAN
Output Level Control (Bridged-T pad)		M
Selector Switch (10 position) no stops	304A-801	GBY

PARTS LIST (continued)

Description	Part No.	Source
Selector Switch (11 position)	304A-805	GBY
Dial (0-9)	147594	M
Dial (0-10)	107011	M
Search Switch		CRL
Local-Remote Switch, 8-pole, 2 position	3990337F	OAK
Knobs, 3/4" and 1"		K-K
Lamp Holder for dials	1001313	M
Lamp Dial illuminating	#757	GE

WARRANTY

MONTRONICS, INC., warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify MONTRONICS, INC., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.
2. On receipt of the shipping instructions, forward the instrument, prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

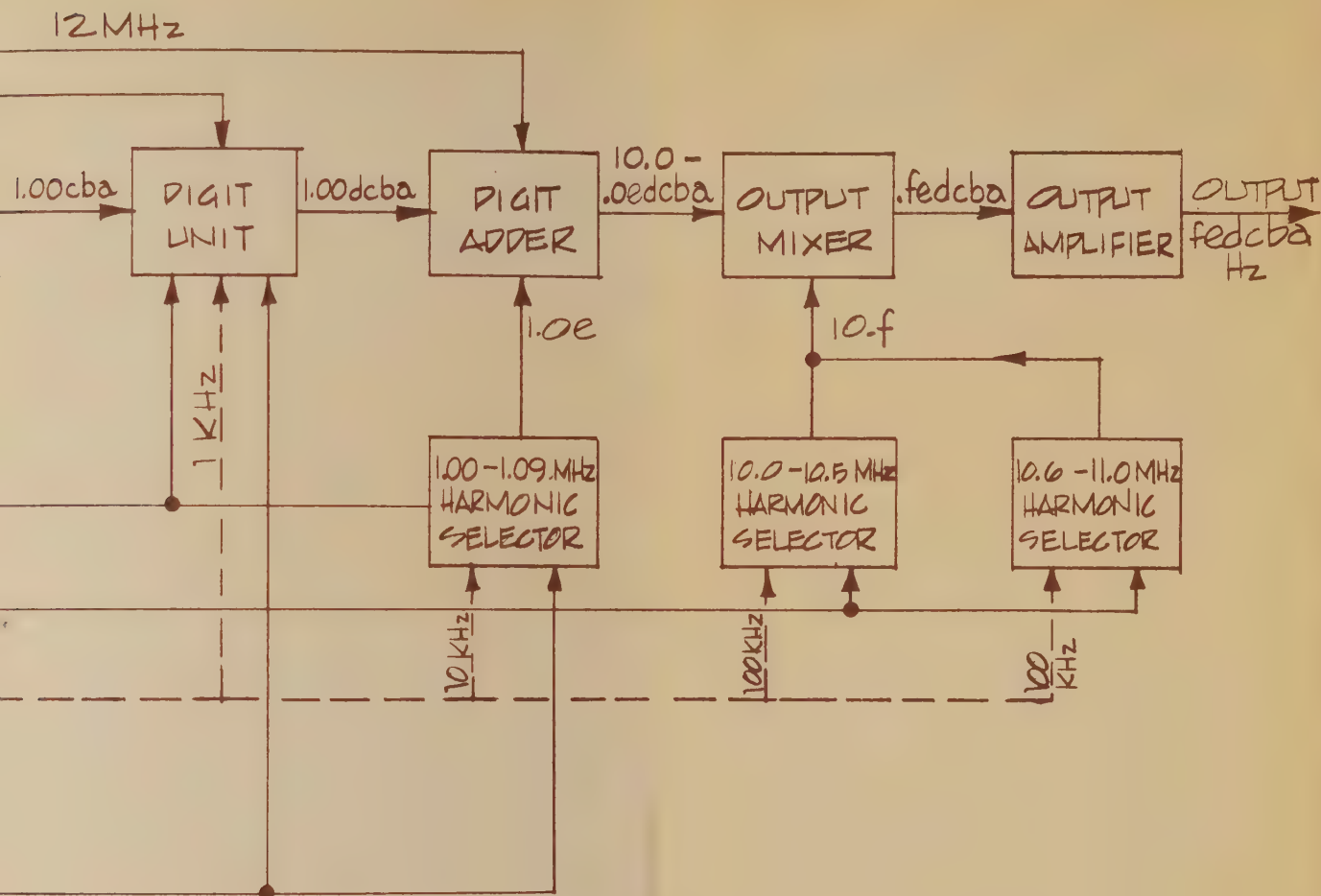
All shipments of MONTRONICS, INC., instruments should be made via airfreight prepaid. The instrument should be shipped in the original packing carton, or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

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MONTRONICS, INC., will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

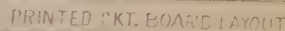
MONTRONICS, INC., SUBSIDIARY OF JOHN FLUKE MFG. CO., INC., P. O.
BOX 7428, SEATTLE 33, WASHINGTON, 98133. TELEPHONE (206) 776-3141



DRAWING		SERIAL NO 180 & ON		DESCRIPTION		OWN CKD APPD	
FTM CMC	6/66	 JOHN FLUKE MFG. CO., INC. P.O. BOX 7428, SEATTLE 33, WN.		BLOCK DIAGRAM			
CHKD B Malloy	6/8/66						
KG ENG							
ROJ ENG CFM	7/6/66						
MFG ENG RAM	7/15/66						
NG DEPT 27B	7/15/66	PART NO		SIZE	DRAWING NUMBER		
MATERIAL: —				B	303A-150		
FINISH: —		SCALE —		WEIGHT —	SHEET 1	OF 1	REV



FACTORY SELECTED COMPONENT



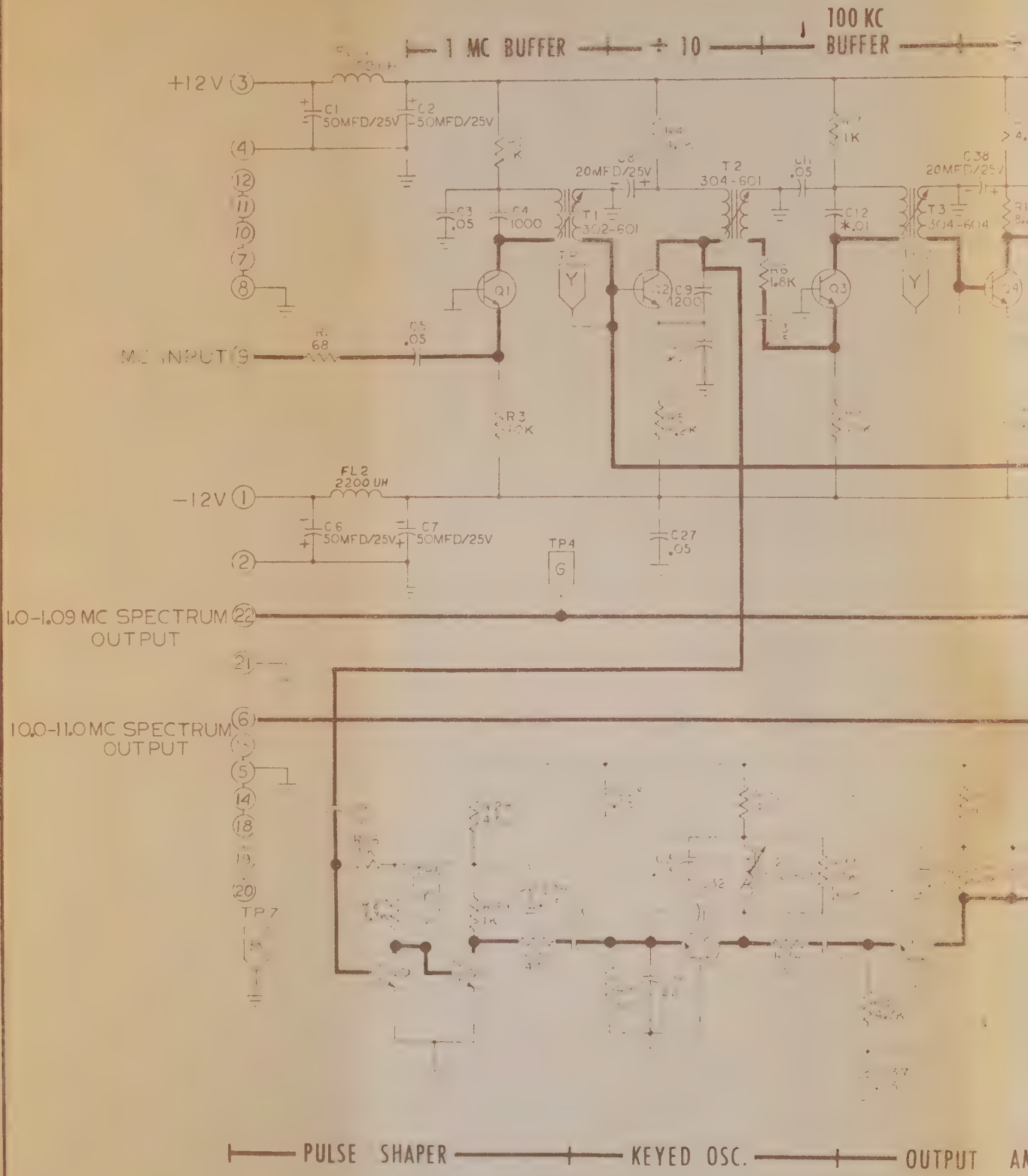


MULTIPLIER X3 AMP

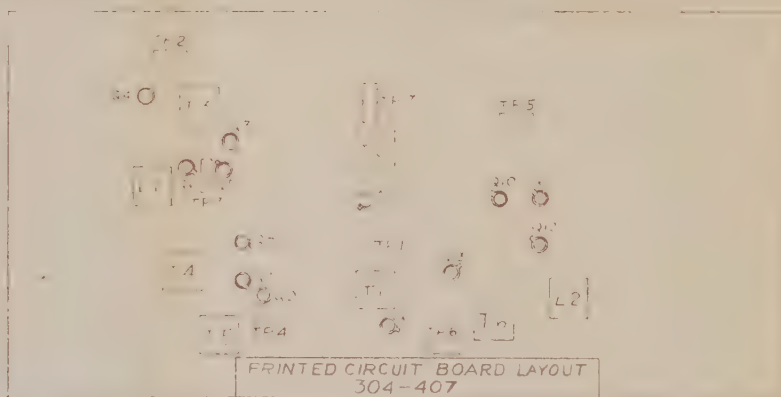
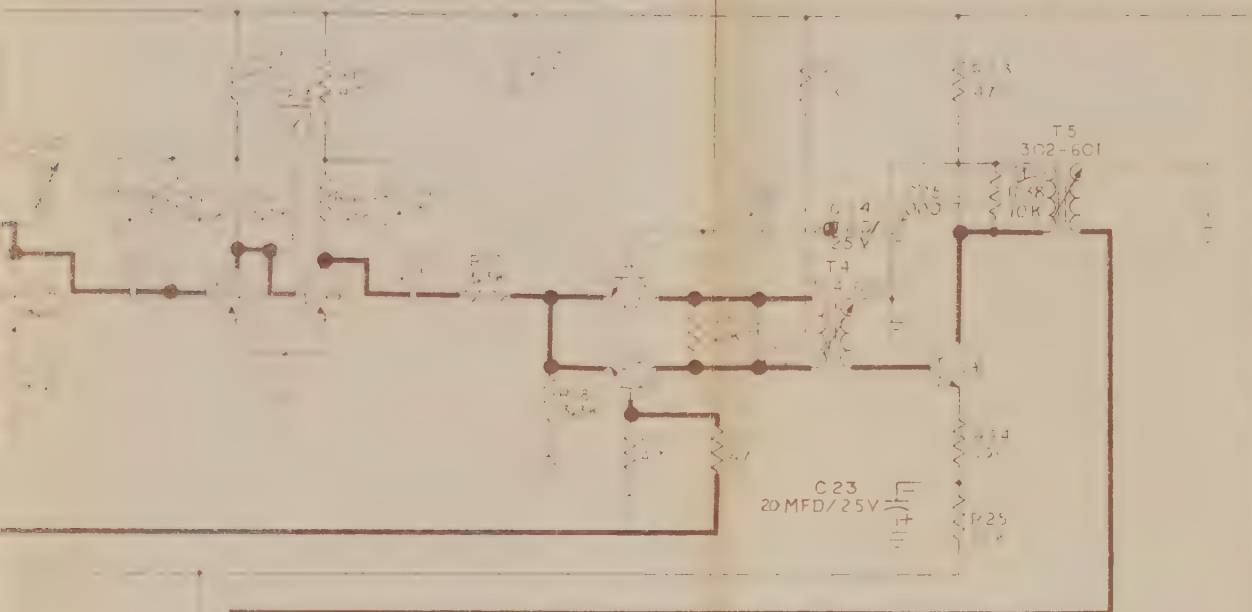
[illegible]

NEXT ASSAY	SERIAL NUMBER	PART NO.

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PULSE SHAPER — GATED AMP — OUTPUT AMP —



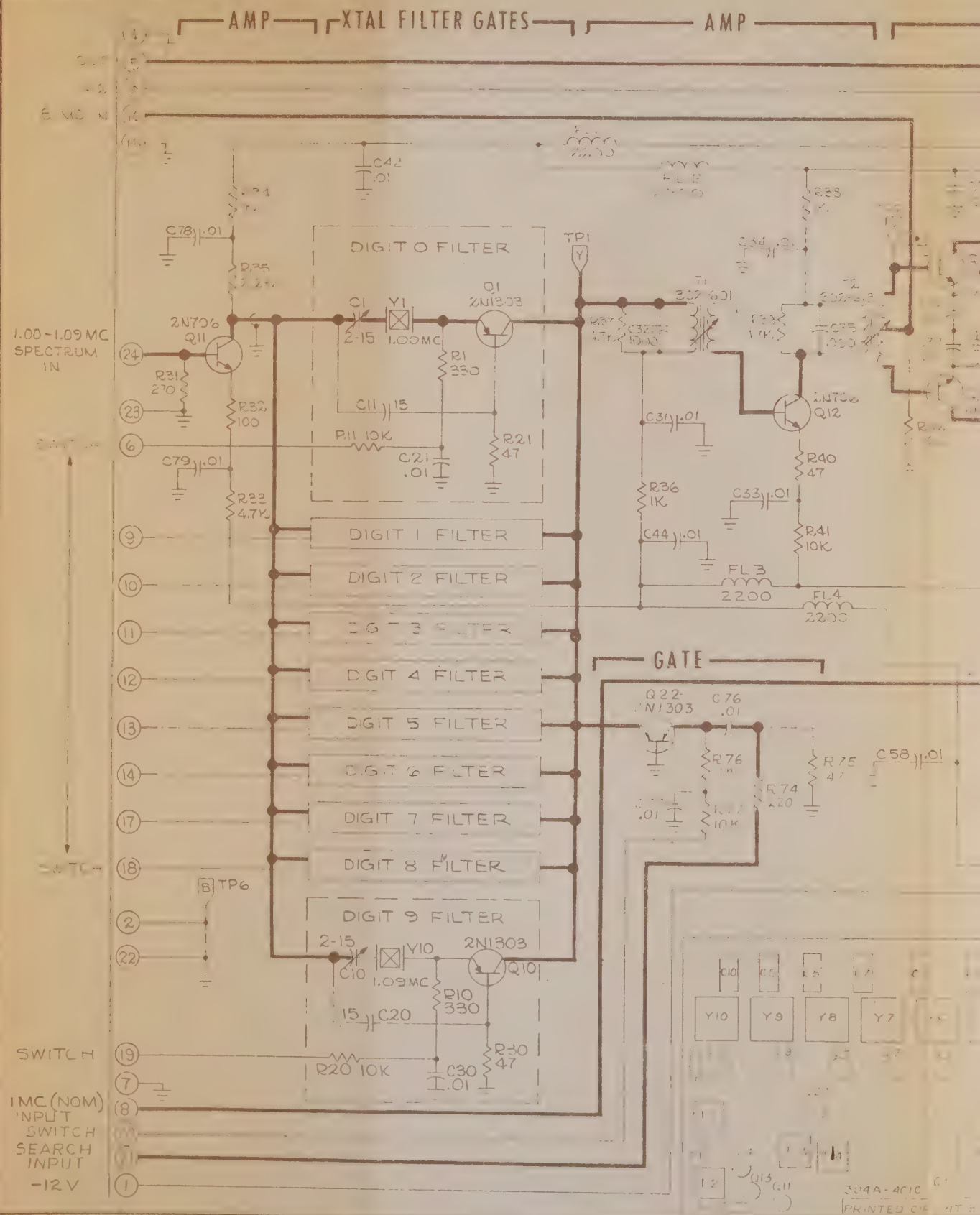
ALL TRANSISTORS ARE 2N706
 * MALLORY PVC MYLAR CAPACITOR $\pm 10\%$ TOLERANCE

HEAVY LINE INDICATES FORWARD SIGNAL PATH
 ALL CAPACITORS IN WHOLE NUMBERS ARE IN UF UNLESS OTHERWISE NOTED
 ALL CAPACITORS IN DECIMAL NUMBERS ARE IN PF UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE ONE QUARTER WATT 5% UNLESS OTHERWISE NOTED
 ALL RESISTOR VALUES ARE IN OHMS
 ALL WELDELECTORS ARE IN UF

QTY REQ'D	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT - MK	SYM	ITEM NO.
LIST OF MATERIAL									
DO NOT SCALE DRAWING		ELCC APPD	DATE		MONTRONICS INC. BOZEMAN, MONTANA SUBSIDIARY OF JOHN POUKE MFG CO. INC.				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		MECH APPD							
ANGULAR TOLERANCE		CHECKED							
DECIMAL 2 PL TOLERANCE		DRAWN							
DECIMAL 1 PL TOLERANCE						DUAL SPECTRUM GENERATOR			
DIMENSIONING & TOLERANCING PER MIL-STD-8		DESIGN APPROVAL		CODE IDENT NO.		SIZE		D 304A-107A	
PART MARKING IN ACCORDANCE WITH MIL-STD 130A						SCALE		SHEET	

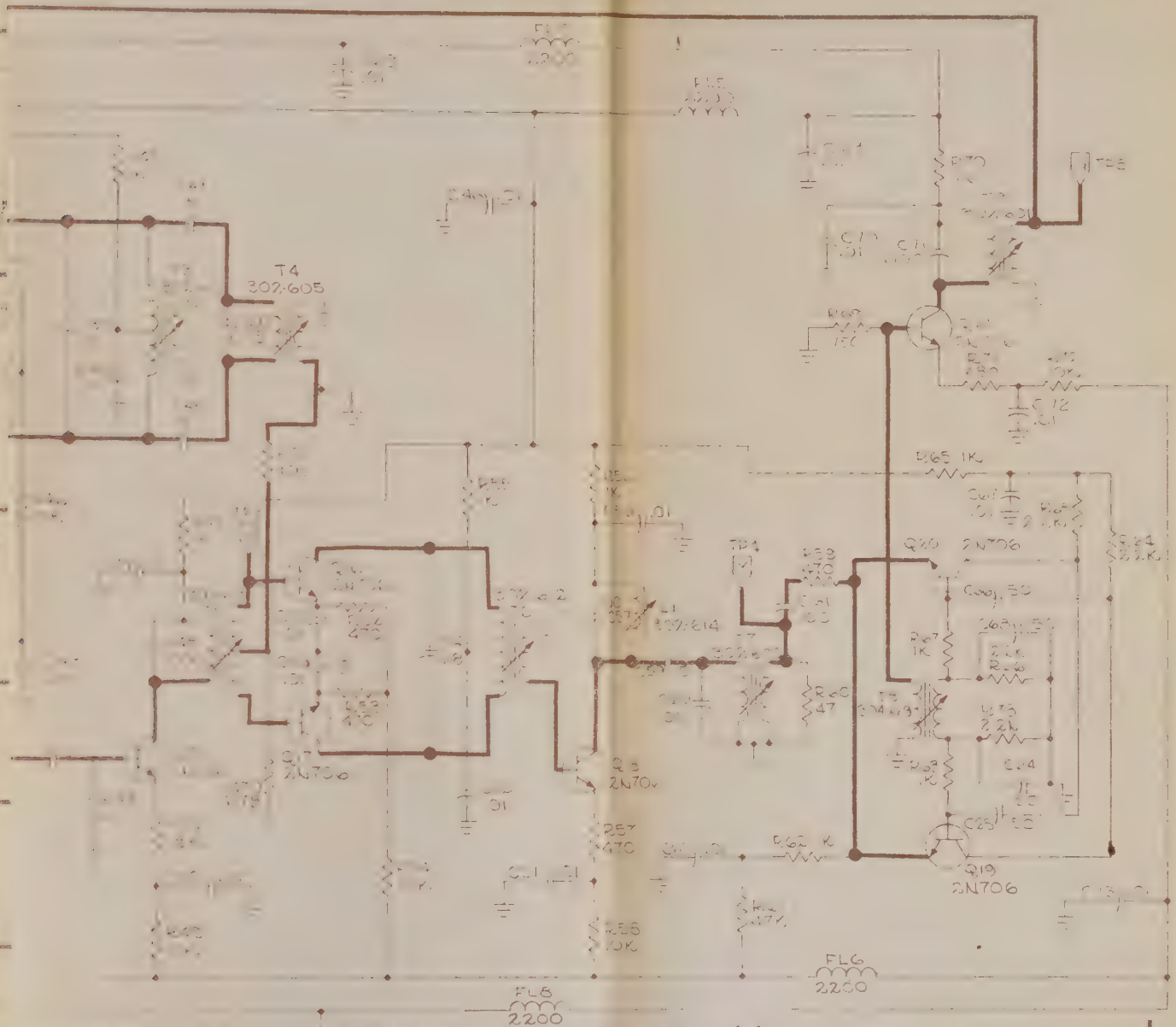
APPLICATION		
NEXT ASSY	SERIAL NUMBER	PART NO

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IXER

AMP



AMP

MIXER

AMP

DIVIDER

HEAVY LINE INDICATES FORWARD SIGNAL PATH.
 ALL CAPACITORS IN WHOLE NUMBERS ARE IN UUF UNLESS OTHERWISE NOTED
 ALL CAPACITORS IN DECIMAL NUMBERS ARE IN UF UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE ONE QUARTER WATT 5% UNLESS OTHERWISE NOTED
 ALL RESISTOR VALUES ARE IN OHMS
 ALL INDUCTORS (FL) ARE IN MH

DO NOT SCALE DRAWING	ELEC APPD <i>DA Hall</i>	DATE <i>12/20/64</i>	BOZEMAN	MONTRONICS, INC.	MONTANA
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES	MECH APPD				
ANG. LAR TOLERANCE	CHECKED				
FRACTIONAL TOLERANCE					
DECIMAL TOL TOLERANCE	DRAWN <i>ANDREJ</i>	<i>12/20/64</i>			
DIMENSIONING & TOLERANCING PER MIL-STD-8	DESIGN APPROVAL		IDENT NO	D 304-101	
PART MARKING IN ACCORDANCE WITH MIL-STD-30A					

TEST POINT	WAVEFORM	LEVEL
5		
4		
7		
3		
24		
23		
1		
2		
6		
9		
10		
11		
12		
13		
14		
17		
18		
19		
20		
21		
22		
25		

1. The circuit is a schematic diagram of a digital filter system. It includes a power supply section with +12V and -12V rails. A spectrum input is connected to a 2N706 tube. The output of the tube is connected to a series of filters labeled DIGIT 0 FILTER through DIGIT 9 FILTER. Each filter has a specific frequency response, ranging from 1.00MC to 1.09MC. The filters are connected to a search gate, which is controlled by a search signal input and a search gate switching line.

OUTPUT

+12V

SPECTRUM INPUT

-12V

SWITCHING LINES

SEARCH SIGNAL INPUT

SEARCH GATE SWITCHING LINE

AMP FILTER-AMP-GATES

DIGIT 0 FILTER

1.00MC

DIGIT 1 FILTER

1.01MC

DIGIT 2 FILTER

1.02MC

DIGIT 3 FILTER

1.03MC

DIGIT 4 FILTER

1.04MC

DIGIT 5 FILTER

1.05MC

DIGIT 6 FILTER

1.06MC

DIGIT 7 FILTER

1.07MC

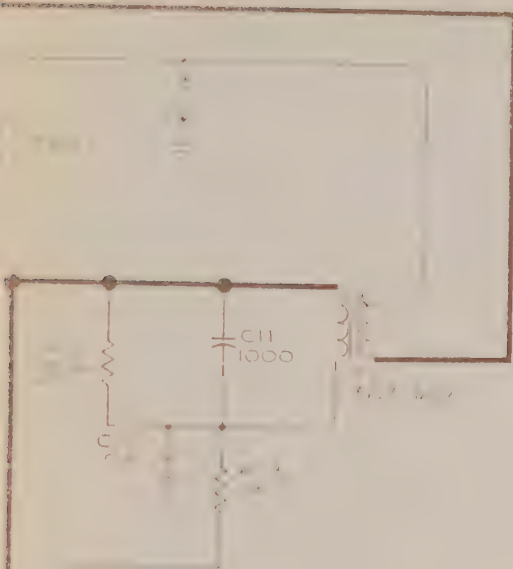
DIGIT 8 FILTER

1.08MC

DIGIT 9 FILTER

1.09MC

SEARCH GATE



CIRCUITS		Y1
DIGIT 0 FILTER		1.00 MC
1	1	1.01 MC
2	2	1.02 MC
3	3	1.03 MC
4	4	1.04 MC
5	5	1.05 MC
6	6	1.06 MC
7	7	1.07 MC
8	8	1.08 MC
9	9	1.09 MC
10	10	1.10 MC

HEAVY LINE INDICATES FORWARD SIGNAL PATH
 ALL CAPACITORS IN WHOLE NUMBERS ARE IN PPF UNLESS OTHERWISE NOTED
 ALL CAPACITORS IN DECIMAL NUMBERS ARE IN PPF UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE ONE QUARTER WATT UNLESS OTHERWISE NOTED
 ALL RESISTOR VALUES ARE IN OHMS
 ALL WINDING VALUES ARE IN TURNS

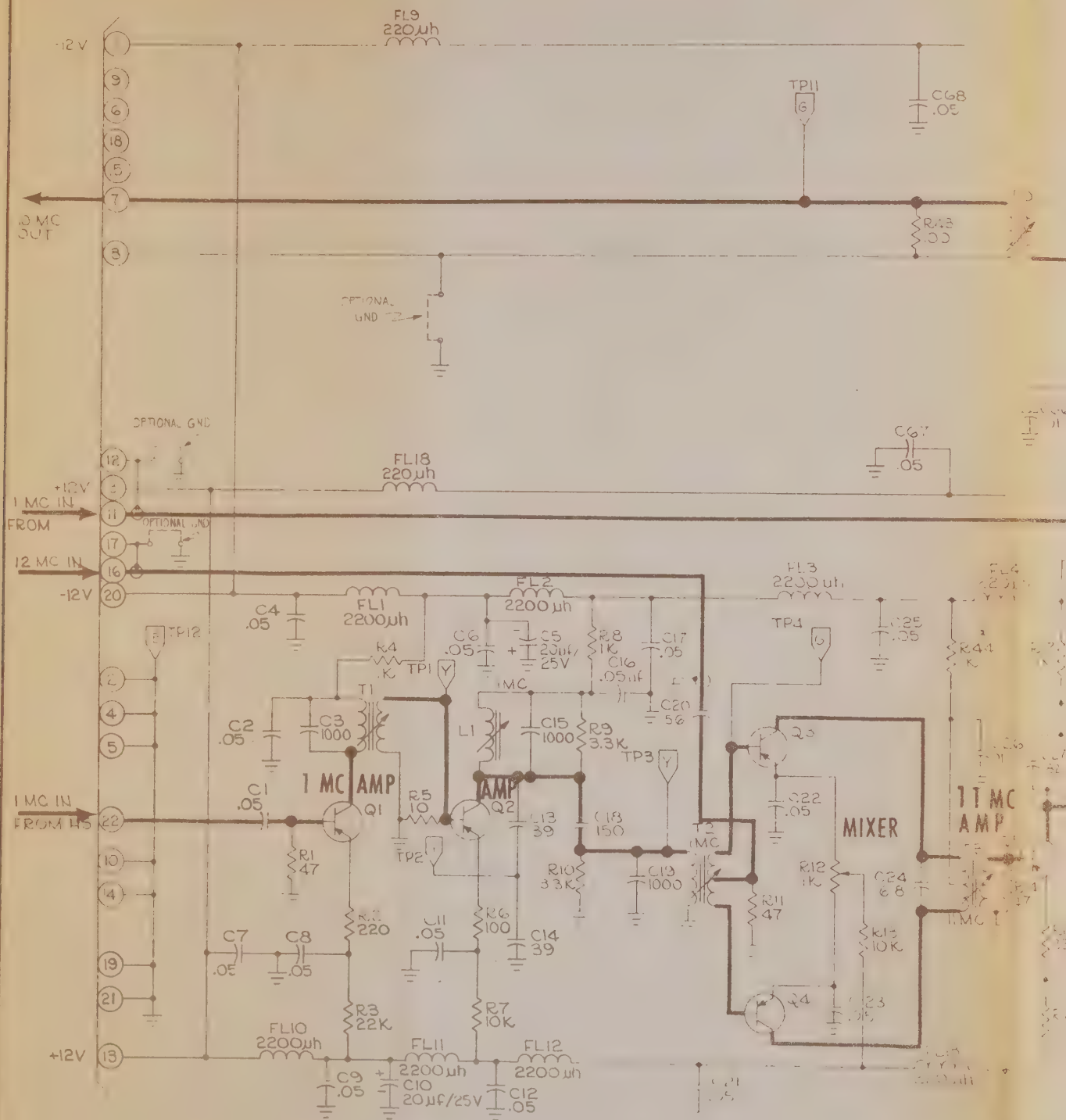
1 ALL FILTER CIRCUITS ARE THE SAME AS THE DIGIT 0 FILTER EXCEPT FOR THE VALUES OF Y1. SEE TABLE I

2 FACTORY SELECTED COMP.

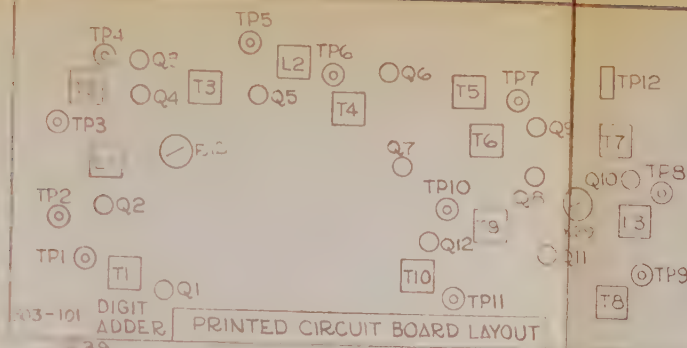
RELEASE	QTY REQ'D	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT MK	SYM	ITEM NO
LIST OF MATERIAL										
DO NOT SCALE DRAWING			ELEC APPD	DATE		MONTRONICS INC. BOZEMAN, MONTANA SUBSIDIARY OF JOHN FLUKE MFG. CO. INC.				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			MECH APPD			IMC HARMONIC SELECTOR				
ANGULAR TOLERANCE			CHECKED	6/6/61						
DECIMAL 2 PL TOLERANCE			DRAWN	6-9-4						
DECIMAL 1 PL TOLERANCE			LJ Houser							
DIMENSIONING & TOLERANCING PER MIL-STD-8 PART MARKING IN ACCORDANCE WITH MIL-STD-130A			DESIGN APPROVAL			CODE IDENT NO	SIZE	D 304A-111B		
						SCALE	SHEET			

APPLICATION		
DATE	SERIAL NUMBER	PAGE TWO

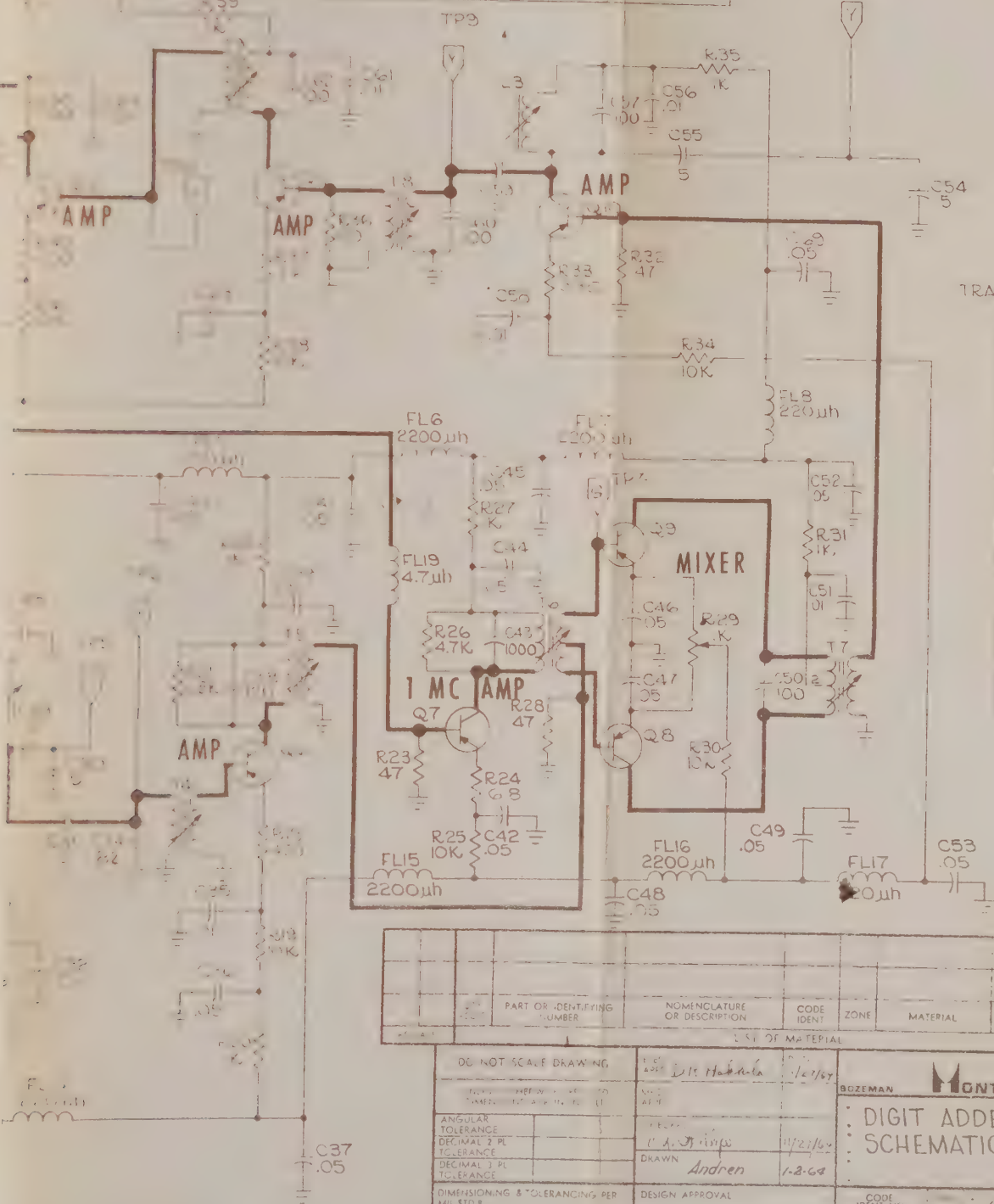
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HEAVY LINE INDICATES FORWARD SIGNAL PATH
 ALL CAPACITORS IN WHOLE NUMBERS ARE IN P.F. UNLESS OTHERWISE NOTED
 ALL CAPACITORS IN DECIMAL NUMBERS ARE IN P.F. UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE ONE QUARTER WATT 5% UNLESS OTHERWISE NOTED
 ALL RESISTOR VALUES ARE IN OHMS
 ALL INDUCTORS (FL) ARE IN UH
 ALL TRANSISTORS ARE 2N2189



REVISIONS			
SYM	ZONE	DESCRIPTION	DATE
1		CHANGED PER CR #101	



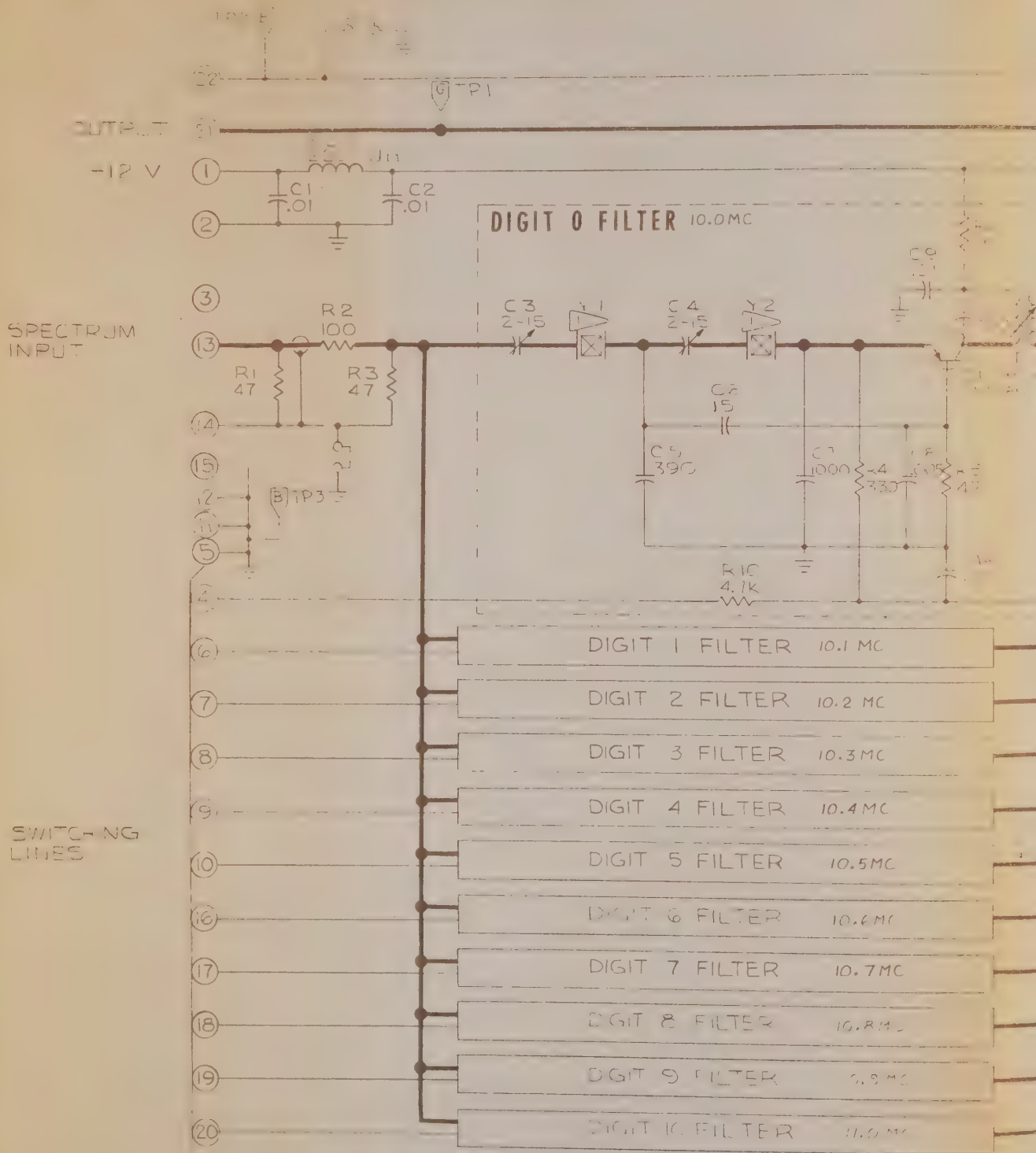
TRANSFORMER INDUCTOR

NO	
1	302-615A
L2	302-614
L3	302-614
T1	302-601
T2	302-613
T3	302-612
T4	302-605
T5	302-605
T6	302-613
T7	302-612
T8	302-605
T9	302-605
T10	302-605

PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH
DO NOT SCALE DRAWING					
DRAWN: <i>Andren</i> 1-2-68					
DESIGN APPROVAL					
BOARD NO.					
MONTRONICS, INC. DIGIT ADDER SCHEMATIC					
305-101					

APPLICATION		
NAME	DATE	REV.

REPRODUCED FROM THE DOCUMENTS OF THE
 NATIONAL BUREAU OF STANDARDS
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 NATIONAL BUREAU OF STANDARDS
 REPRODUCED FROM THE DOCUMENTS OF THE
 NATIONAL BUREAU OF STANDARDS

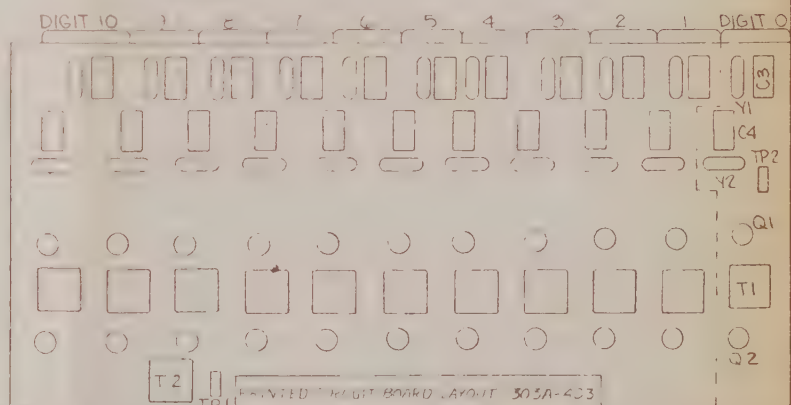


CIRCUITS	Y1 & Y2
DIGIT 0 FILTER	10.0 MC
DIGIT 1 FILTER	10.1 MC
DIGIT 2 FILTER	10.2 MC
DIGIT 3 FILTER	10.3 MC
DIGIT 4 FILTER	10.4 MC
DIGIT 5 FILTER	10.5 MC
DIGIT 6 FILTER	10.6 MC
DIGIT 7 FILTER	10.7 MC
DIGIT 8 FILTER	10.8 MC
DIGIT 9 FILTER	10.9 MC
DIGIT 10 FILTER	11.0 MC

HEAVY LINE INDICATES FORWARD SIGNAL PATH
 ALL CAPACITORS IN WHOLE NUMBERS ARE IN PFD UNLESS OTHERWISE NOTED
 ALL CAPACITORS IN DECIMAL NUMBERS ARE IN PFD UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE ONE QUARTER WATT 5% UNLESS OTHERWISE NOTED
 ALL WEEDECTORS (ED) ARE IN OHMS

1 ALL FILTER CIRCUITS ARE THE SAME AS THE DIGIT 0 FILTER EXCEPT FOR THE FREQUENCY OF Y1 & Y2. SEE TABLE I

2 FACTORY SPECIFIED



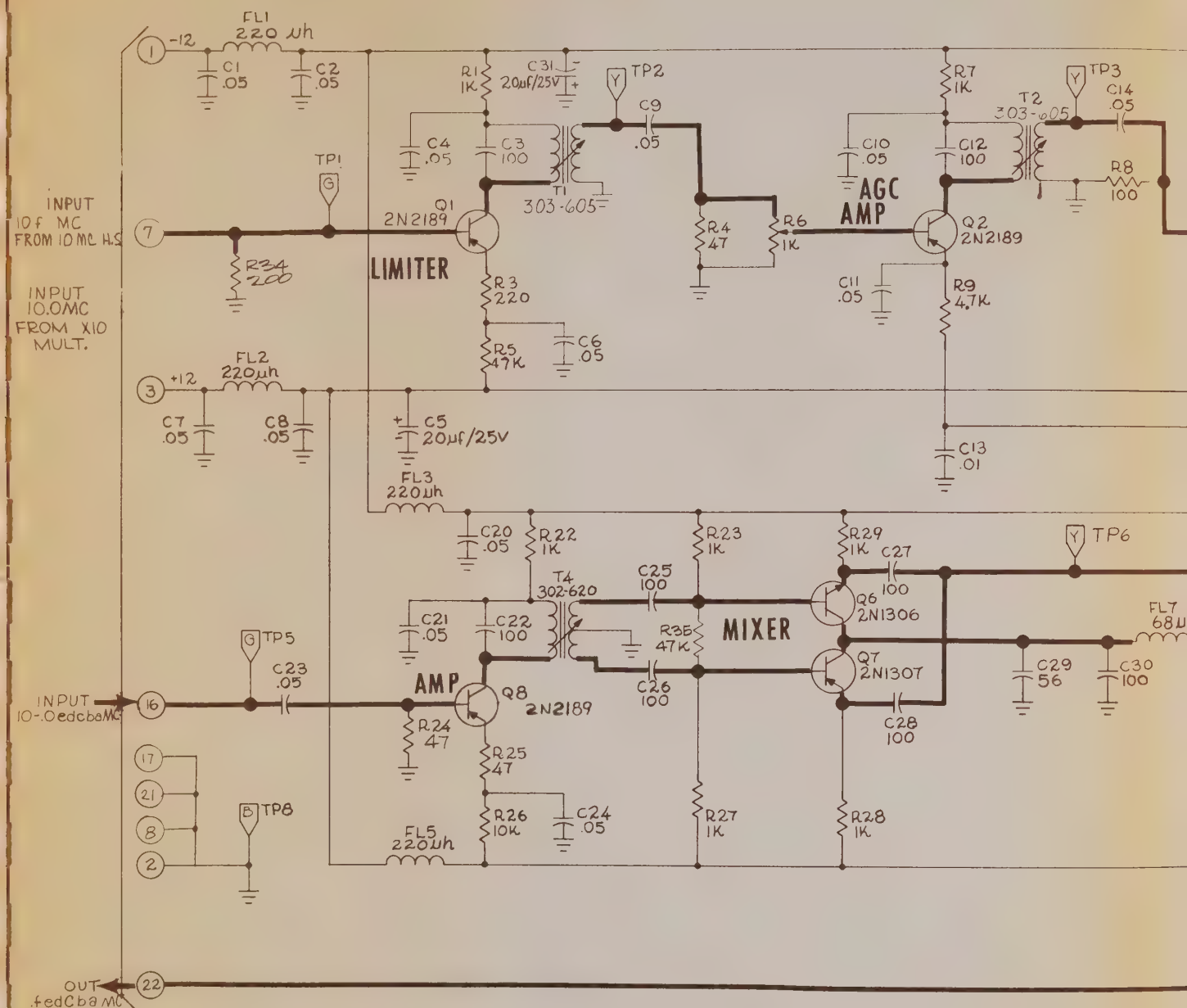
RELEASE	QTY REQ'D	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT. MK	SYM	ITEM NO.
LIST OF MATERIAL										
DO NOT SCALE DRAWING			ELEC APPD	DATE	MONTRONICS INC. BOZEMAN, MONTANA SUBSIDIARY OF JOHN FLUXE MFG. CO. INC.					
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			MECH APPD	11/2/64	10 HARMONIC SELECTOR					
ANGULAR TOLERANCE			CHECKED	11/2/64						
DECIMAL 2 PL TOLERANCE			DRAWN	11/2/64						
DECIMAL 1 PL TOLERANCE			DESIGN APPROVAL							
DIMENSIONING & TOLERANCING PER MIL-STD-8			CODE IDENT NO.		SIZE	D 30 5A-103				
PART MARKING IN ACCORDANCE WITH MIL-STD-130A			SCALE		SHEET					

APPLICATION

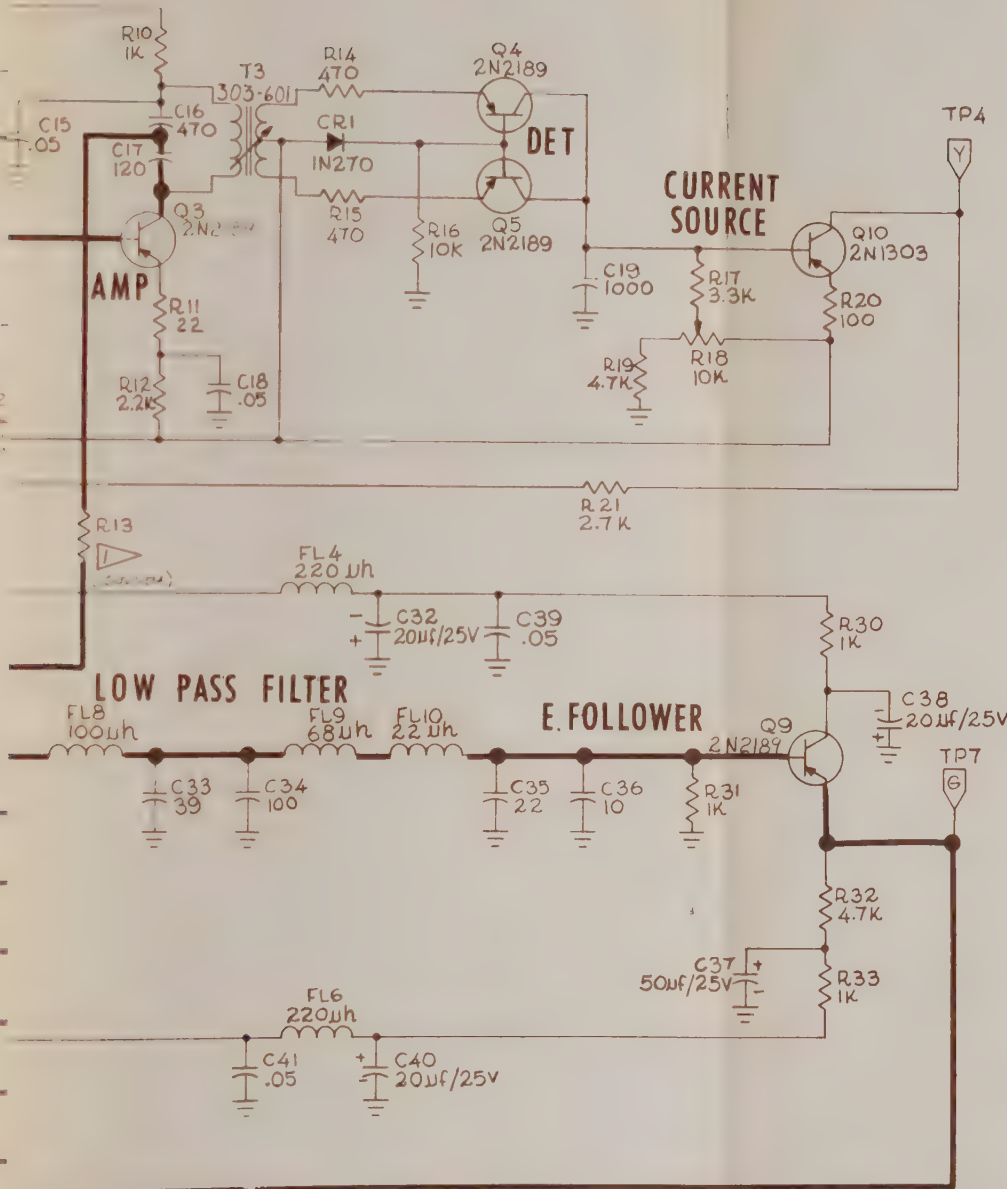
SERIAL NUMBER

PART NO.

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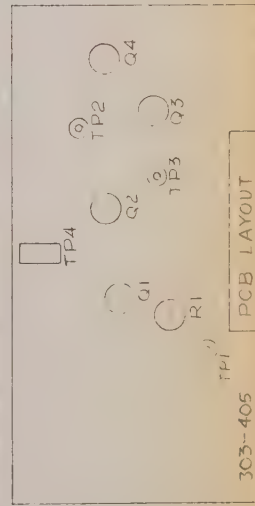
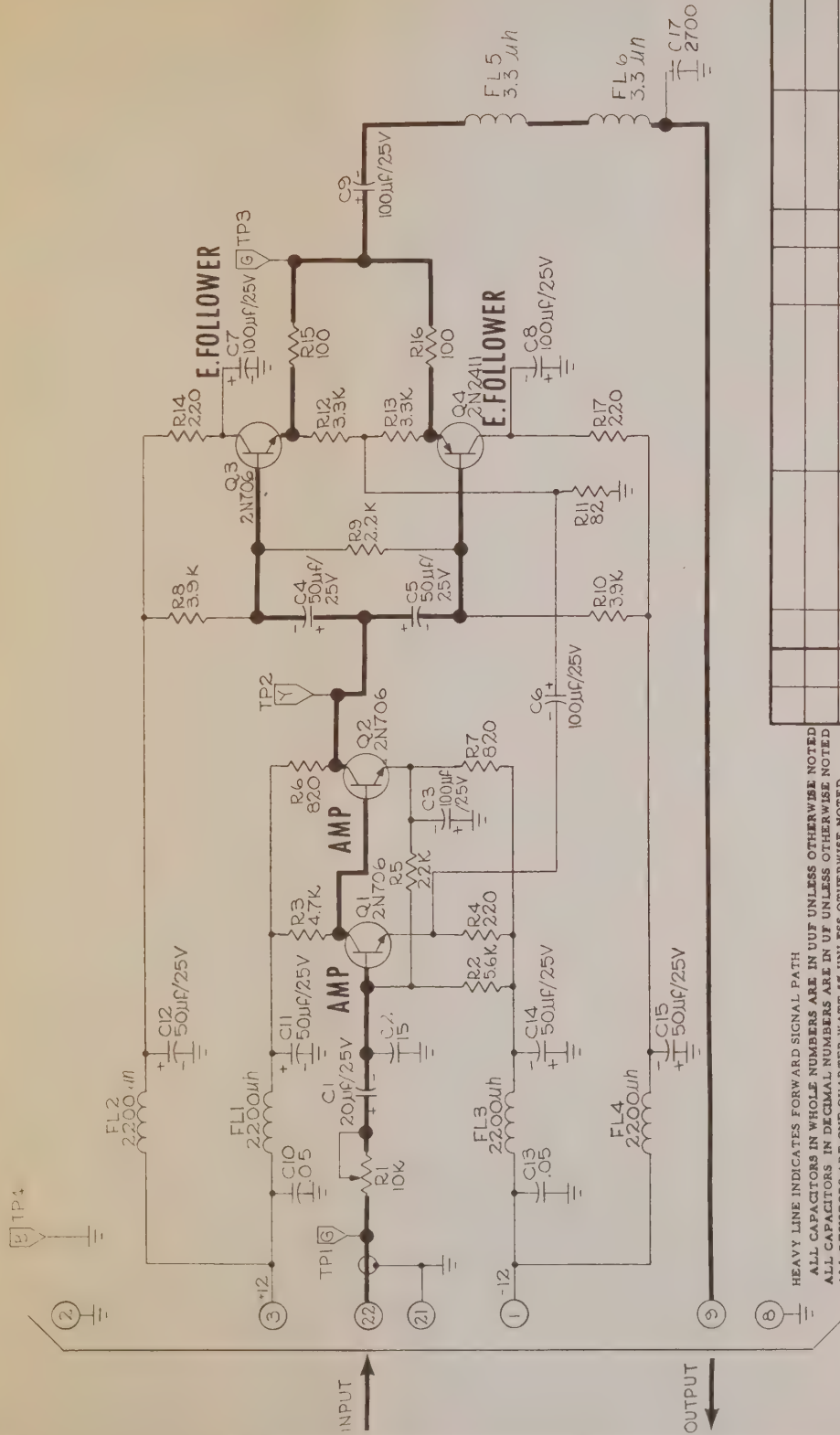
REVISIONS						
SYM	ZONE	DESCRIPTION			DATE	APPROVAL
1		ADDED R 35			01/05	CTM
2		CHANGED R 34 FROM 47K TO 200K (S/N 180103)			01/06	CTM



UNLESS OTHERWISE NOTED
UNLESS OTHERWISE NOTED
OTHERWISE NOTED

RELEASE	QTY REQ'D	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT - MK	SYM	ITEM NO.
LIST OF MATERIAL										
DO NOT SCALE DRAWING			ELEC APPD	DATE	BOZEMAN MONTRONICS, INC. MONTANA					
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			MECH APPD		OUTPUT MIXER SCHEMATIC					
ANGULAR TOLERANCE			CHECKED	7/24/66						
DECIMAL 2 PL TOLERANCE			DRAWN	2/25/64						
DECIMAL 3 PL TOLERANCE										
DIMENSIONING & TOLERANCING PER MIL-STD-8			DESIGN APPROVAL		CODE IDENT NO.		SIZE		REV	
PART MARKING IN ACCORDANCE WITH MIL-STD-130A			BOARD NO. 303-404		D		303A-104		2	
					SCALE		SHEET 1 of 1			

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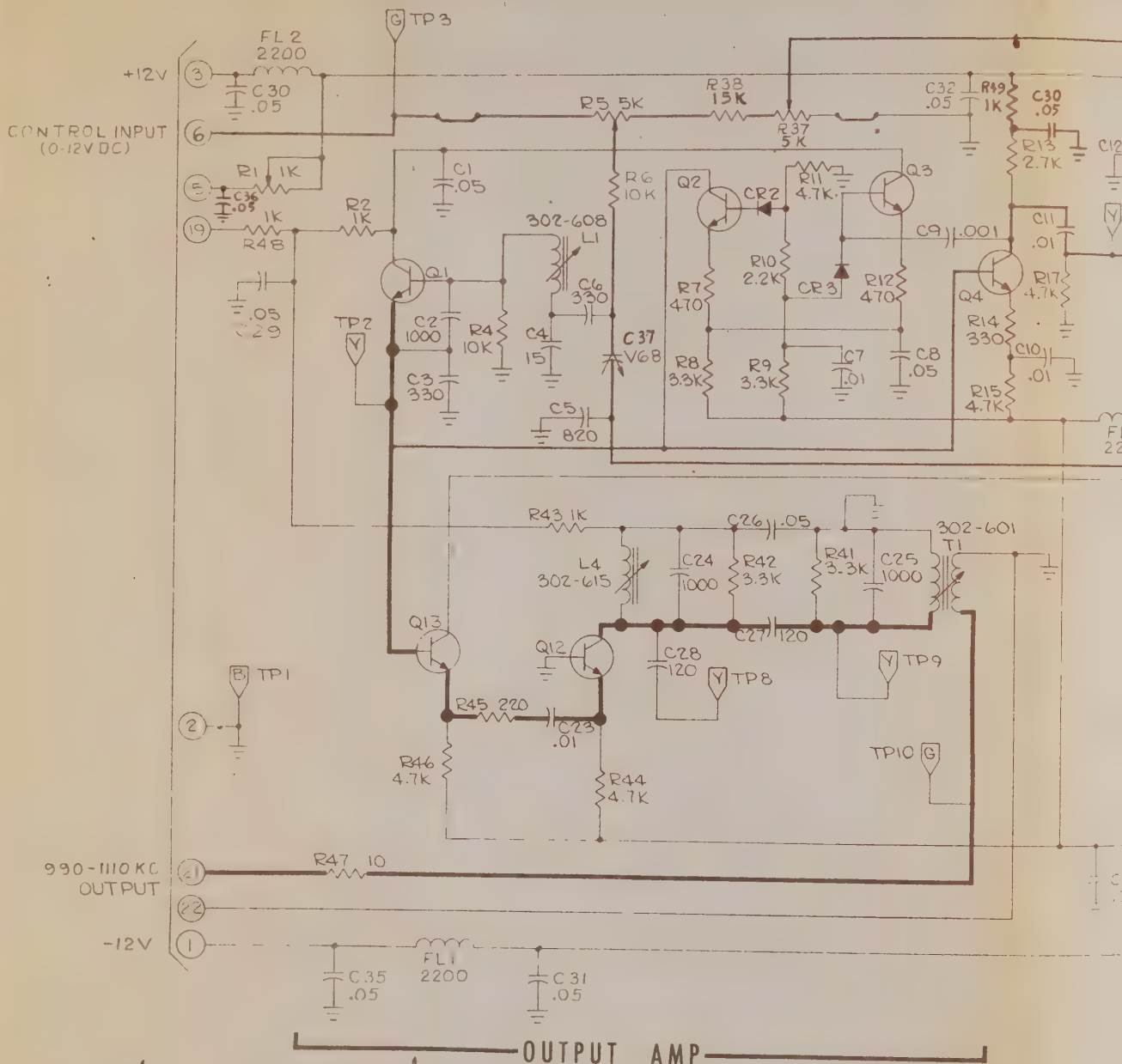


DO NOT SCALE DRAWING		ELEC APPL		DATE		BOZEMAN		MONTRONICS, INC.		MONTANA	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		MECH APPD		7/9/64				OUTPUT AMP			
ANGULAR TOLERANCE		CHECKED						SCHEMATIC			
DECIMAL PL TOLERANCE		DRAWN		2.23.64							
DIMENSIONING & TOLERANCING PER MIL-STD-130A		DESIGN APPROVAL									
PART MARKING IN ACCORDANCE WITH MIL-STD-130A											
BOARD NO. 303-405											
303-405											

APPLICATION		
NEXT ASSY	SERIAL NUMBER	PART NO.

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OSCILLATOR A.G.C. AMP



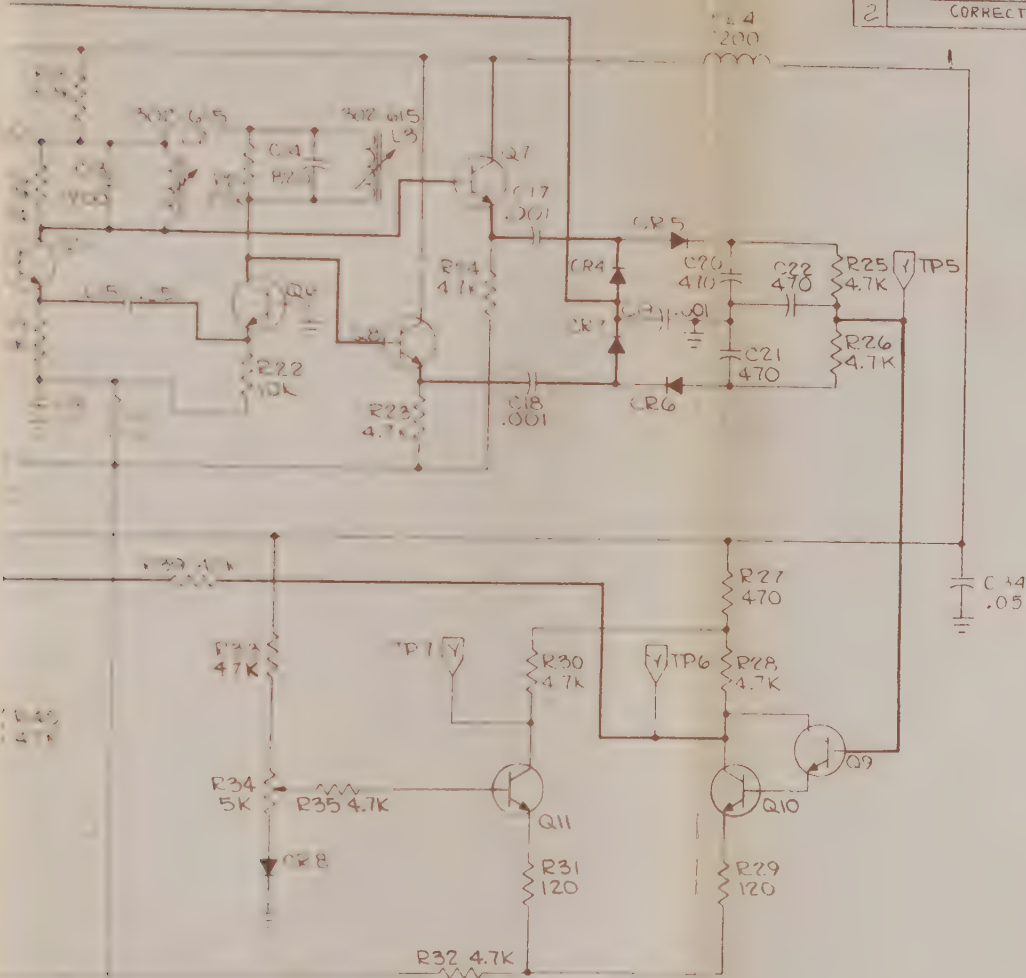
ALL CAPACITORS IN WHOLE NUMBERS ARE IN UUF UNLESS OTHERWISE SPECIFIED.
ALL CAPACITORS IN DECIMAL NUMBERS ARE IN UF UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS ARE ONE QUARTER WATT 5% UNLESS OTHERWISE SPECIFIED.
ALL RESISTOR VALUES ARE IN OHMS.

ALL TRANSISTORS ARE 2N706.
ALL DIODES ARE IN270. EXCEPT WEEDUCTORS (FL1) ARE IN 1M.

— INDICATES SIGNAL PATH
— INDICATES CONTROL PATH
LAST USED C37
LAST USED R49

DISCRIMINATOR DETECTOR

REVISIONS			
SYM	ZONE	DESCRIPTION	DATE
C		DELETED R36 R3 CHANGED R39 FROM 39K TO 15K ADDED C36 FROM PINS 5 TO GND	4/26/65
1		ADDED R49 1K & C30 .05 CHANGED R33 FROM 22K TO 47K CHGD DISCRIMINATOR COMPARTOR TO DISCRIMINATOR DETECTOR CHGD ERROR AMP TO COMPARTOR & ERROR AMP ADDED C37 TO V68	4/26/65
2		CORRECTED CAPACITOR REF NOS	10/10/66



COMPARATOR & ERROR AMP

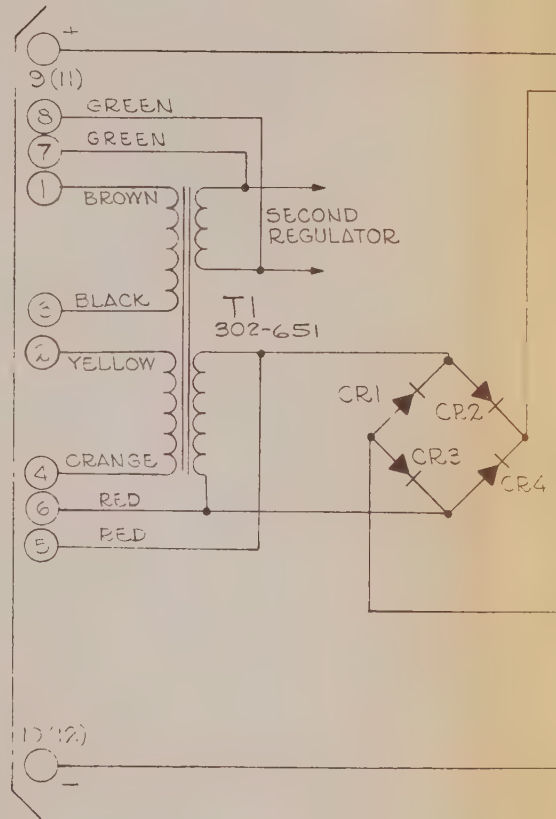
IF OTHERWISE NOTED
IS OTHERWISE NOTED
ERWISE NOTED

AS NOTED

RELEASE	QTY REQ'D	PART NO IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT MK	SYM	ITEM NO
LIST OF MATERIAL										
DO NOT SCALE DRAWING			ELEC APPD	DATE 1/26/65		BOZEMAN MONTRONICS, INC. MONTANA				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE TENTH INCHES			MECH APPD			SEARCH OSCILLATOR				
ANGULAR TOLERANCE			CHECKED							
DECIMAL 2 PL TOLERANCE			DRAWN	R THOMPSON		51-64				
DE TMA, P TOLERANCE			DESIGN APPROVAL			CODE IDENT NO		SIZE	D 304A-120C	
DIMENSIONING & TOLERANCING PER MIL-STD-8 PART MARKING IN ACCORDANCE WITH MIL-STD-130A							SCALE		SHEET	
									REV 2	

APPLICATION		
NEXT ASSY	SERIAL NUMBER	PART NO.

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WRITTEN CONSENT

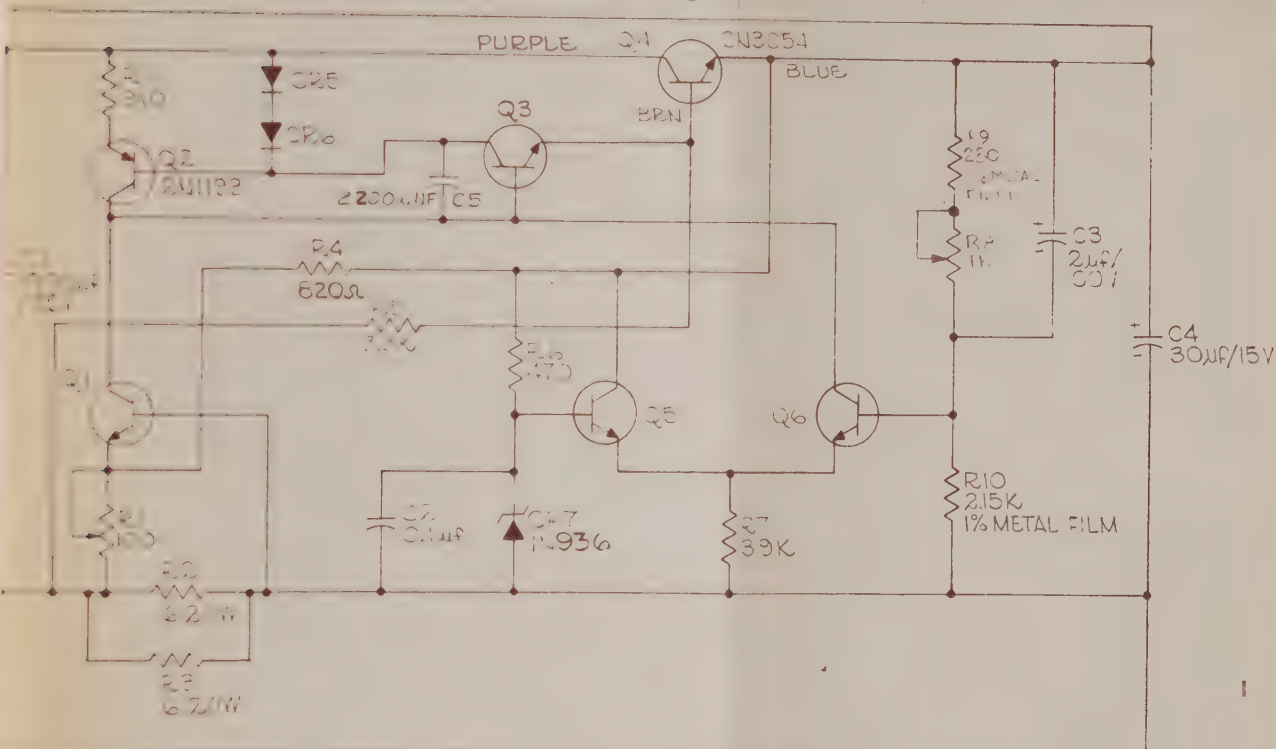


ALL TRANSISTORS ARE 203489 UNLESS
OTHERWISE SPECIFIED (DIRECT REPLACEMENT)

ALL DIODES ARE IN4022 UNLESS
OTHERWISE SPECIFIED

RESISTORS ARE IN OHMS $\pm 5\%$, $\frac{1}{2}W$
UNLESS OTHERWISE NOTED

REVISIONS			
SYM	ZONE	DESCRIPTION	DATE
B		CR Z23 & Z24	12-11-64
C		CHANGED C5 FROM 2000PF TO 2200PF	1/2/65
D		CHNG'D CRT FROM IN936 TO IN936	1/2/65
E		CHGD CRT FROM IN936 TO IN936 CHGD R4 FROM 1K TO 620Ω	6/2/65
F		REPLACED 5746 RESISTORS	7/15/65
G		CHANGED DIODE & TRANSISTOR	7/15/65



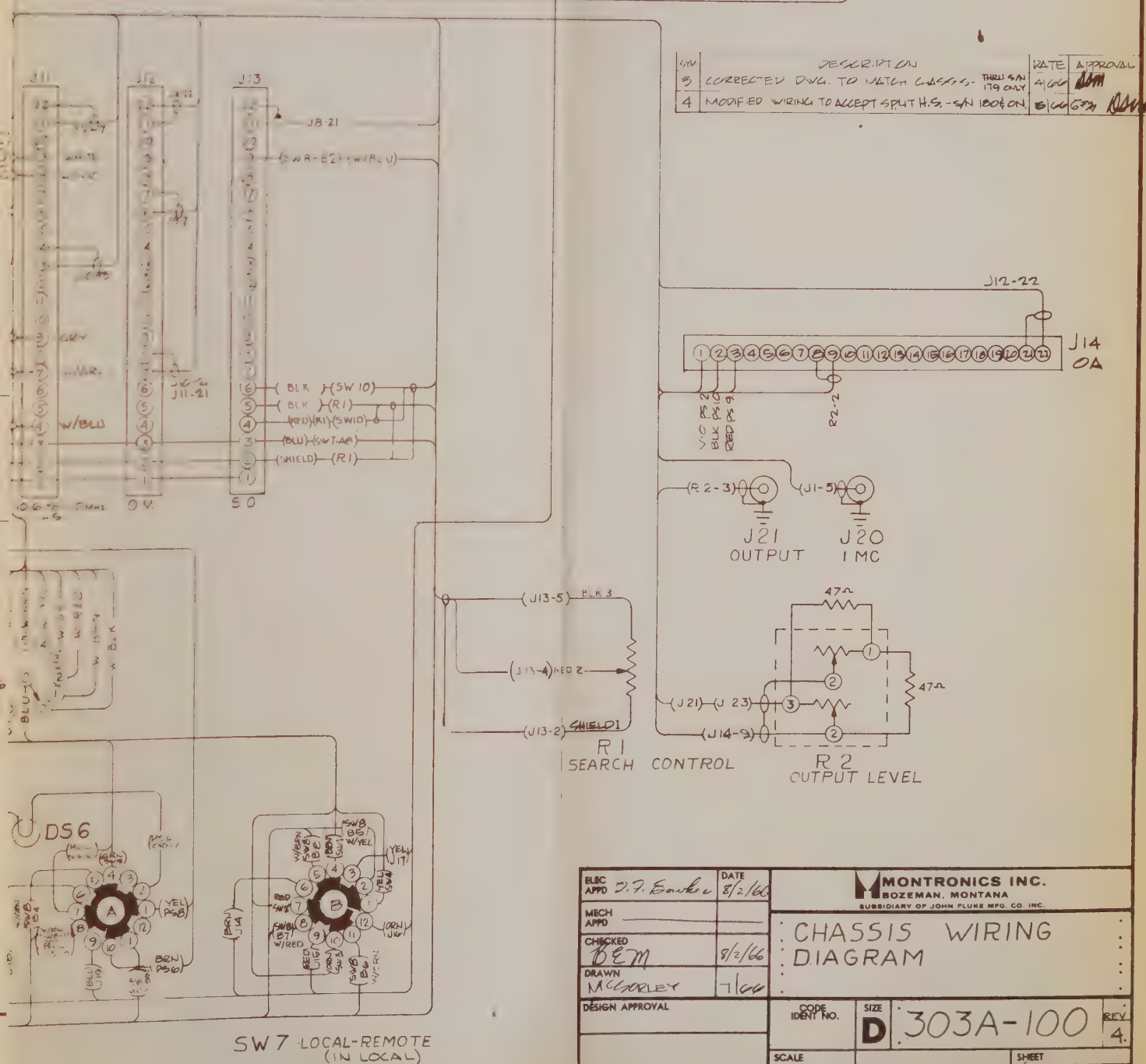
2N697)

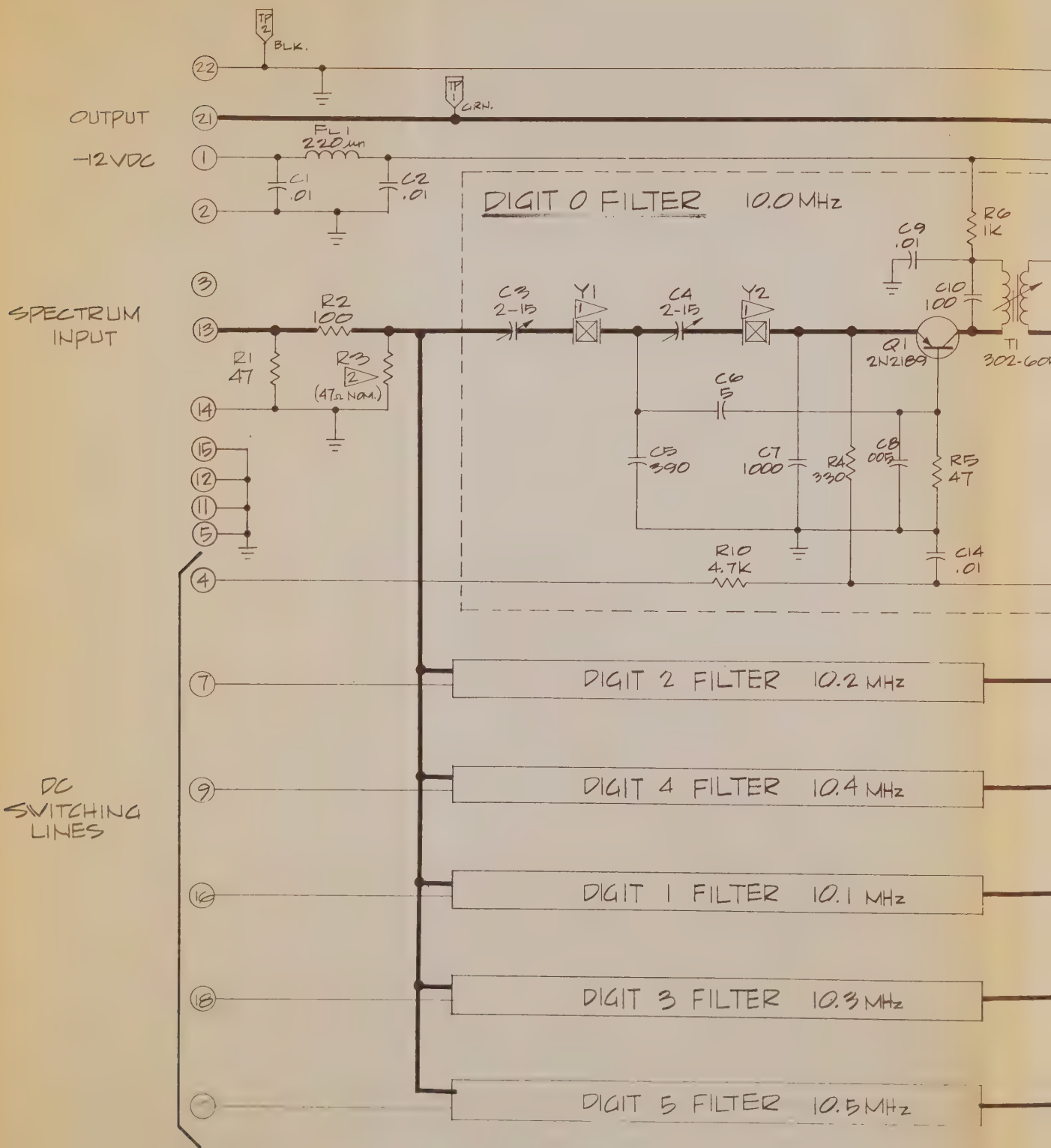
QTY REQ'D	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	ZONE	MATERIAL	FINISH	PT. MK	SYM	ITEM NO.
RELEASE	LIST OF MATERIAL								
DO NOT SCALE DRAWING		ELEC APPD	DATE		BOZEMAN MONTRONICS, INC. MONTANA				
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		MECH APPD	5/21/64		± 12 V POWER SUPPLY				
ANGULAR TOLERANCE		CHECKED	4/21/64						
DECIMAL 2 PL TOLERANCE		DRAWN: ANDREN	4/2/64						
DECIMAL 3 PL TOLERANCE									
DIMENSIONING & TOLERANCING PER MIL-STD-8 PART MARKING IN ACCORDANCE WITH MIL-STD-130A		DESIGN APPROVAL		CODE IDENT NO.		SIZE		302-126	
		4-24-64		SCALE		1311		SHEET OF 2	

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The diagram illustrates the internal wiring of a television set, organized into several functional sections:

- POWER SUPPLY:** Located at the top left, it shows the connection of power lines (BLACK, GREEN, WHITE) to the main power supply unit. It includes a color bar (J14) and a search switch (J26).
- SEARCH IN, IMC IN, OUTPUT, IMC OUT:** These sections are located at the top center and right, showing the connections for the search and imc (intermediate frequency) input and output stages.
- CONNECTORS:** Numerous connectors are shown, including J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J22, J23, J24, J25, and J26. Each connector has a specific pin configuration and wire color coding.
- SWITCHES:** Several switches are shown, including SW1, SW2, SW3, SW4, SW5, SW9, and SW-B SEARCH. These switches are used to control various functions of the television, such as color, contrast, and search.
- RELAYS:** Relays DS1, DS2, DS3, DS4, and DS5 are shown at the bottom, which are used to switch between different input sources or functions.
- WIRE COLOR CODING:** The diagram uses a consistent color coding system for all wires, including WHITE, BLACK, RED, GREEN, BLUE, YELLOW, and various combinations (e.g., W/GRY, W/BLU, W/GRN).





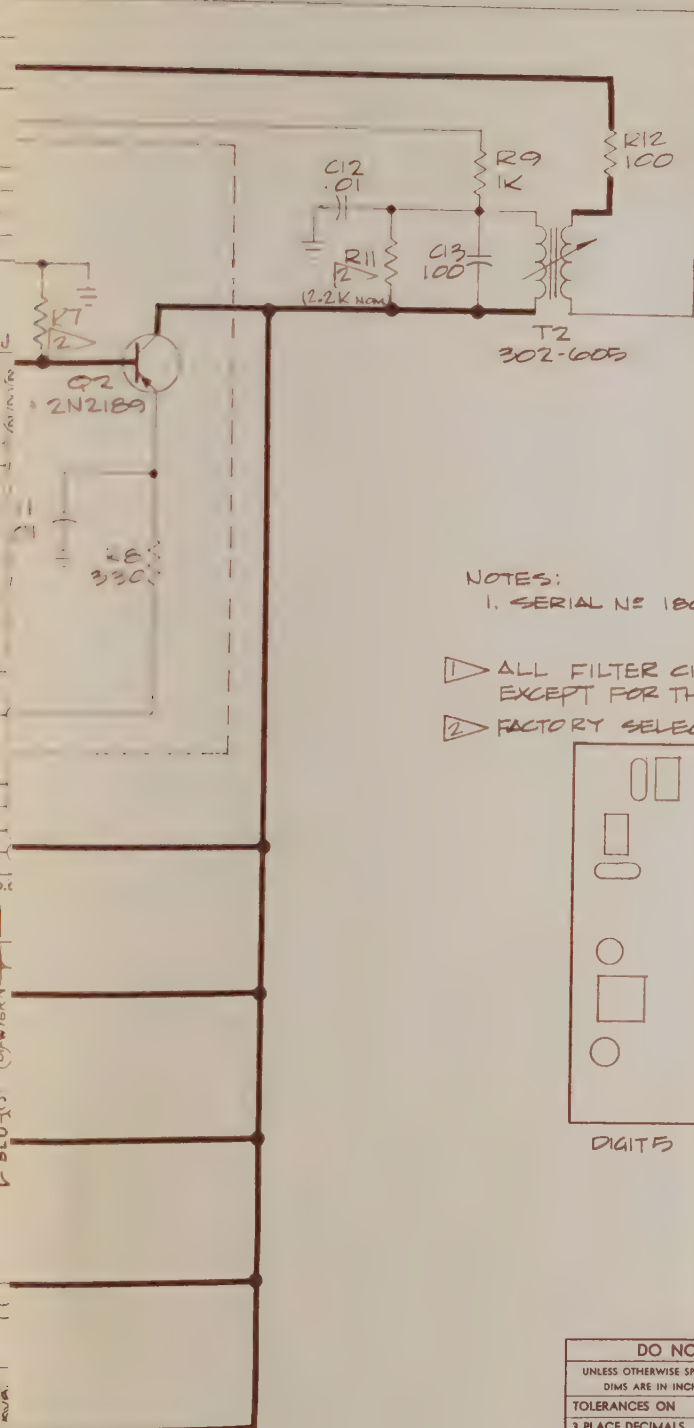


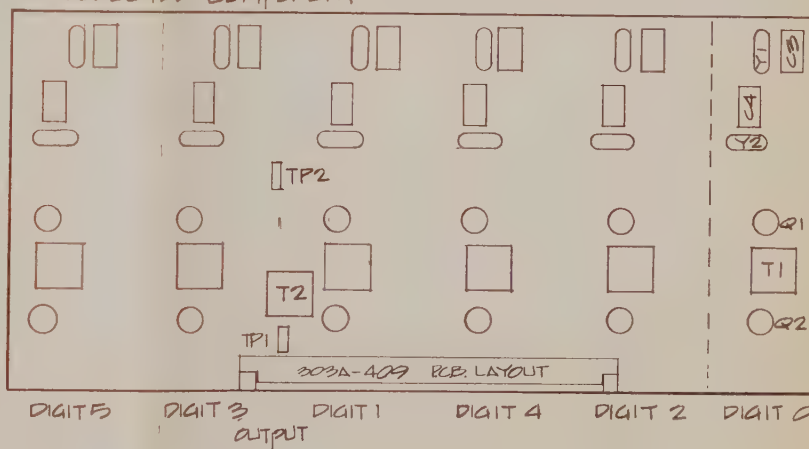
TABLE I

CIRCUIT	Y1 & Y2
DIGIT 0 FILTER	10.0 MHz
DIGIT 2 FILTER	10.2 MHz
DIGIT 4 FILTER	10.4 MHz
DIGIT 1 FILTER	10.1 MHz
DIGIT 3 FILTER	10.3 MHz
DIGIT 5 FILTER	10.5 MHz

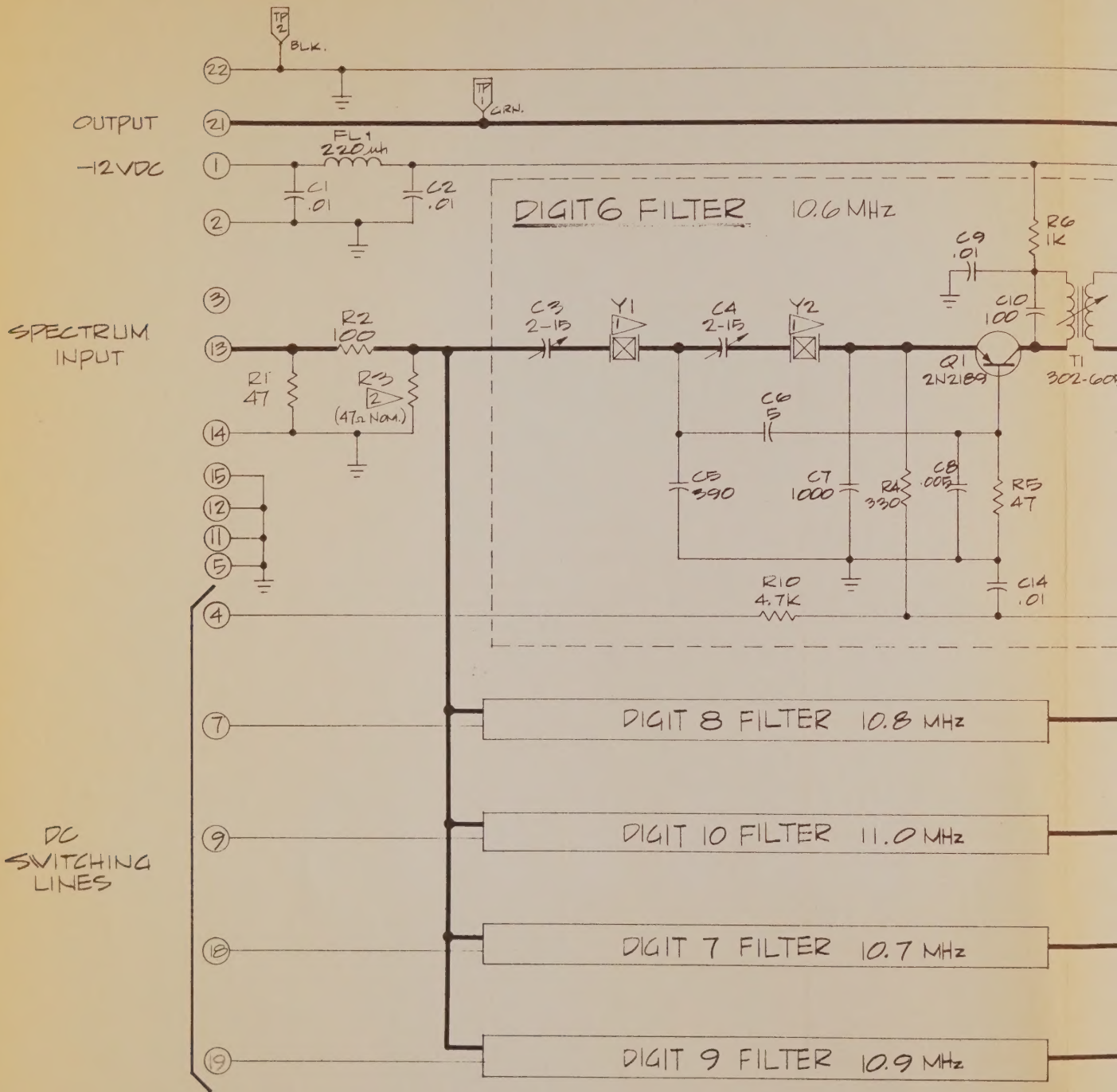
NOTES:

1. SERIAL NO 1804 ON

1. ALL FILTER CIRCUITS ARE THE SAME AS THE "DIGIT 0" FILTER EXCEPT FOR THE FREQUENCY OF "Y1" & "Y2" (SEE TABLE 1-ABOVE)
2. FACTORY SELECTED COMPONENT



DO NOT SCALE DRAWING		REV	DESCRIPTION	DWN	CKD	APP
UNLESS OTHERWISE SPECIFIED DIM'S ARE IN INCHES		DFTM <i>M420RLEY</i> <i>5/66</i>		JOHN FLUKE MFG. CO., INC. P.O. BOX 7428, SEATTLE, WN. 98133		
TOLERANCES ON		CHKD <i>BEM</i> <i>6/4/66</i>				
3 PLACE DECIMALS	± .010	PKG ENG	<i>10.0 TO 10.5 MHZ</i> HARMONIC SELECTOR SCHEMATIC			
2 PLACE DECIMALS	± .02	PROJ ENG <i>GFH</i> <i>7/6/66</i>				
FRACTIONS	±	MFG ENG <i>WMM</i> <i>7/5/66</i>				
ANGLES	±	ENG DEPT <i>278</i> <i>7/15/66</i>				
HOLE DIA:		MATERIAL: _____	PART NO	SIZE	DRAWING NUMBER	
.014 TO .128	+ .005		<i>D 303A-109</i>			
.136 TO .228	+ .010					
.234 TO .500	+ .015	FINISH: _____	SCALE	WEIGHT	SHEET	OF
.500 & ABOVE	+ .020					REV



REV 0 303A-110

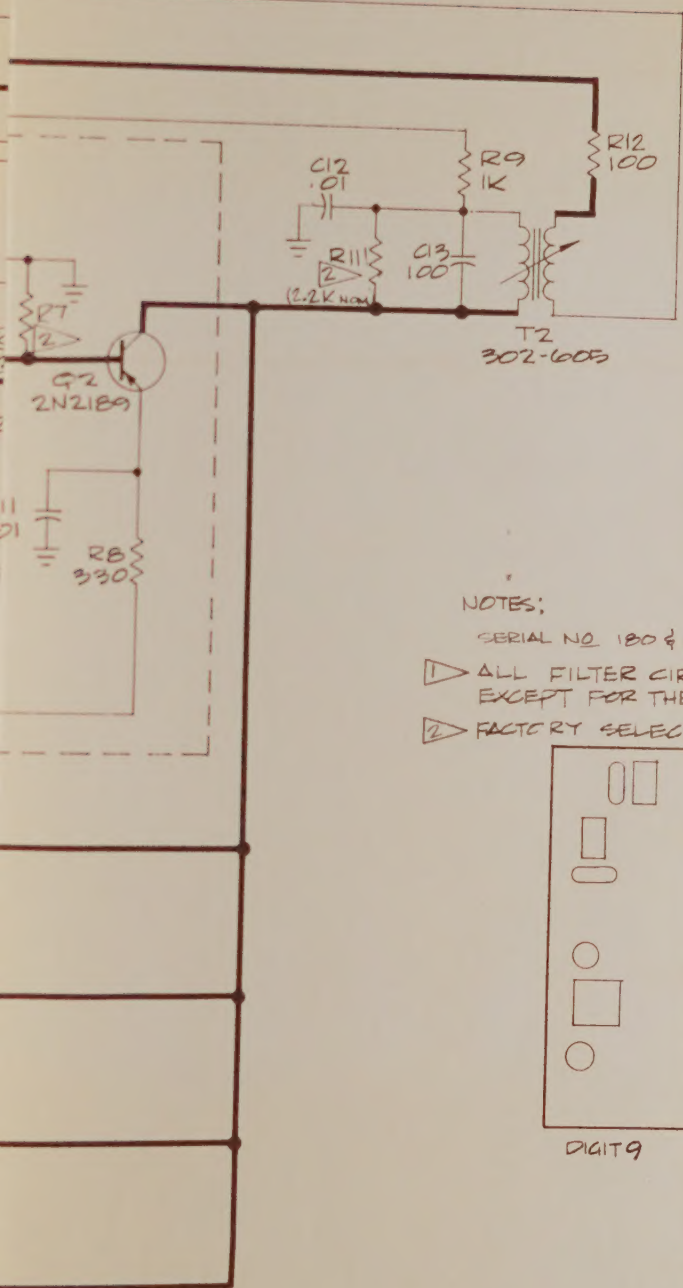
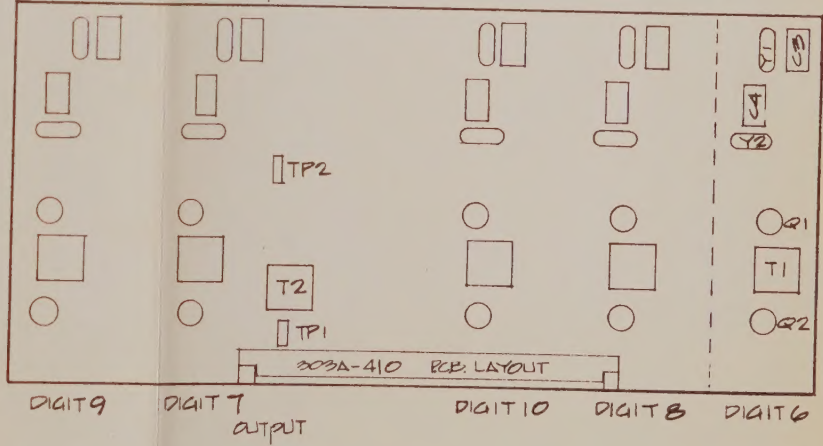


TABLE I	
CIRCUIT	Y1 & Y2
DIGIT 6 FILTER	10.6 MHz
DIGIT 8 FILTER	10.8 MHz
DIGIT 10 FILTER	11.0 MHz
DIGIT 7 FILTER	10.7 MHz
DIGIT 9 FILTER	10.9 MHz

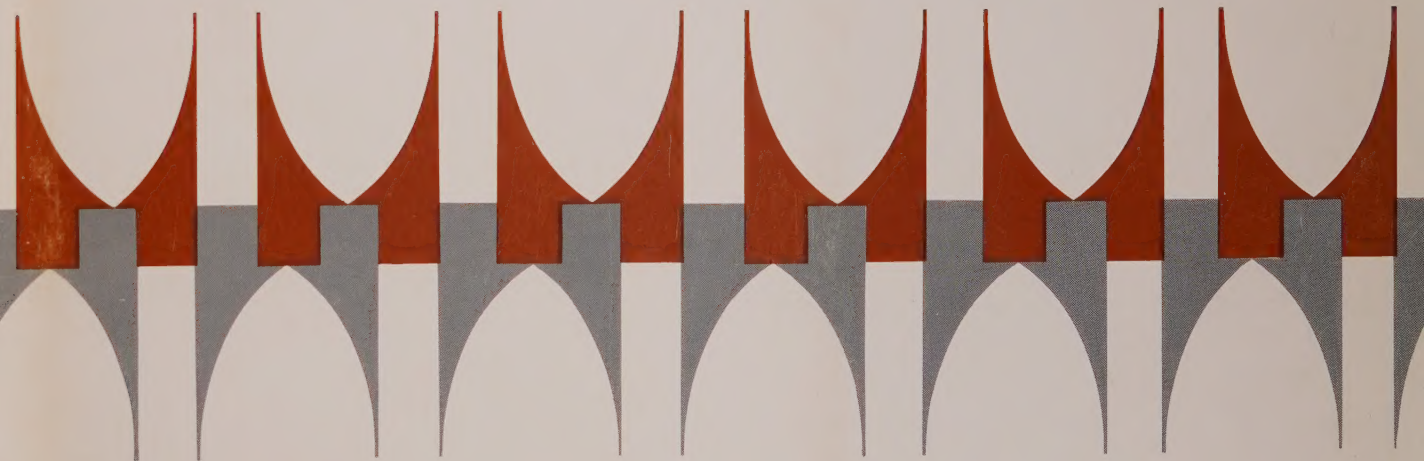
NOTES:

SERIAL NO. 180 & ON

- ALL FILTER CIRCUITS ARE THE SAME AS THE "DIGIT 6" FILTER EXCEPT FOR THE FREQUENCY OF "Y1" & "Y2" (SEE TABLE I-ABOVE)
- FACTORY SELECTED COMPONENT



DO NOT SCALE DRAWING		REV	DESCRIPTION		DWN	CKD	APPD
UNLESS OTHERWISE SPECIFIED DIMS ARE IN INCHES		DFTM M440RLEY	3/6/66	FLUKE JOHN FLUKE MFG. CO., INC. P.O. BOX 7428, SEATTLE, WN. 98133 10.6 TO 11.0 MHz HARMONIC SELECTOR SCHEMATIC			
TOLERANCES ON		CHKD R.M. 11/10/67	6/4/66				
3 PLACE DECIMALS ± .010		PKG ENG					
2 PLACE DECIMALS ± .02		PROJ ENG GPM	7/6/66				
FRACTIONS ± —		MFG ENG RDM	7/15/66				
ANGLES ± —		ENG DEPT JFB	7/15/66				
HOLE DIA:		MATERIAL: —		PART NO	SIZE	DRAWING NUMBER	
.014 TO .128 + .008		FINISH: —		D 303A-110			
.128 TO .228 + .010				SCALE	WEIGHT	SHEET	OF
.228 TO .380 + .015							REV
.380 & ABOVE + .020							



MONTRONICS INC.

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